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REHABILITATION OF COONEY DAM SPILLWAYS

AS PREPARED FOR

Montana Department of Natural Resources and Conservation

— IN COOPERATION WITH —

Rock Creek Water Users Association
Carbon County, Montana

HKM Associates
Engineers, Architects and Planners
P.O. Box 31318
Billings, Montana

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April 12, 1978
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Mr. Richard Bondy
Mr. Orrin Ferris
Montana Department of Natural
Resources and Conservation
32 South Ewing Street
Helena, Montana 59601

Gentlemen:

Submitted herewith is an engineering and financial feasibility report presenting the proposed methods of improving the principal spillway and construction of an emergency spillway for Cooney Dam. These improvements will bring the dam within modern design standards and provide a safer structure.

This report has been prepared such that it may be used as a baseline information beginning for a loan application under the Small Reclamation Projects Act, P.L. 84-984 as administered by the USDI, Bureau of Reclamation. Specific details and modifications, of course, would have to be inserted in this report after DNR & C and RCWUA review.

The findings of this report indicated that the project is feasible from an engineering and economic standpoint. The total project cost has been estimated to range from $1,572,500 to $1,821,000 depending upon the final plan. It is recommended that a major part of the funds be secured through a loan and/or grant under P.L. 84-984 and the balance be secured through loans and/or grants from the State of Montana and other federal sources.

It is recommended that this report be expanded and submitted to the Secretary of the Interior as application for a loan in accordance with the provisions of P.L. 84-984.

Respectfully submitted,

HKM ASSOCIATES

A.T. Kersich

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ATK/jbk

Encl:

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SUMMARY REVIEW

LOCATION

Cooney Dam and Reservoir on Red Lodge Creek, approximately 7 miles west of Boyd, Montana.

ORGANIZATION

The dam and reservoir are owned by the Montana Department of Natural Resources and Conservation and all water is sold to members of the Rock Creek Water Users Association. The association operates and maintains the project.

The Rock Creek Water Users Association, Carbon County, Montana was incorporated under the laws of Montana on June 27, 1935. The Department and the Association have the authority to assess the water users as necessary for operation, maintenance and project repairs. The Association currently contracts for 17,750 AF of water from Cooney Reservoir, and the annual assessment is as shown below:

Principal Assessment	$1.00
Regular O & M Assessment	0.25
Newkirk Settlement - Special Assessment	0.10
Repairs Assessment	1.00
	$2.35

At this time, 88 of the 274 contract holders have retired their principal obligation and are paying only the $1.35 annual assessment. The above costs include the reservoir storage costs only. The individual users must also pay delivery costs which include water commissioner fees, construction, operation and maintenance of ditches and diversion works, and on farm delivery costs.

PLAN

Purpose

The dam is presently inadequate to pass the Probable Maximum Flood, and in the event of such an occurrence, the dam would be overtopped and would probably fail. This could lead to loss of life and would certainly cause extensive and irreparable damage to property and land downstream of the dam as evidenced in recent disasters. In addition, the replacement cost of Cooney dam and the value of the water lost during reconstruction would far outweigh the cost of providing protection against this event.

In order to provide adequate protection, two alternative designs were considered. In each, a large emergency spillway is proposed along with increasing the height of the dam. Also in each proposal, the storage capacity of the dam will be increased by 4200 AF. The difference in the two proposals lies in the use of this added storage. In one design, the increased storage will be assigned either to irrigation use or a permanent recreation pool. This alternative will require extensive rehabilitation of the existing principal spillway to provide adequate capacity for passing the 100 year flood. The other design assigns the additional storage to flood control which decreases the 100 year peak outflow requiring less extensive principal spillway rehabilitation. The irrigation alternative is recommended as the best since it provides water at the least cost per acre foot and it provides additional water for irrigation or other beneficial use.

Physical Works

Principal project features are:

1. Excavation of a large emergency spillway with the hydraulic capacity capable of passing the probable maximum flood.

2. Raising the existing dam 5 feet to a new crest elevation of 4265.0 ft. (msl).

3. Placing an ogee crest in the existing principal spillway raising the normal water surface from 4246.0 ft (msl) to 4251.0 thereby increasing active storage by 4200 acre-feet.

4. Rehabilitation of the plunge pool, lower two drop structures and outflow channel of the principal spillway to provide the capability to pass the 100-year flood without damage.

Construction Costs (Irrigation Alt.)

Emergency Spillway Excavation	$ 438,000
Dam Enlargement	195,500
Principal Spillway Rehabilitation	476,800
Subtotal	$ 1,110,400
Contingencies (20%)	222,100
Inflation at 12% per year	159,900
Right-of-Way	37,700
Engineering and Overhead	208,900
Water Rights	1,000
Bureau Participation	40,000
Other Association (State) Costs	41,000
Total Project Cost	$ 1,821,000

Project Financing (Irrigation Alt.)

Loan		$ 890,000
Federal Grant		260,000
Applicant's Contribution		671,000
Acquisition of Right-of-Way	($ 37,000)	
Water Rights	(1,000)	
State Loan and/or Grant, Loan Application and Filing Fee	(633,300)	

O & M Costs

Due to rehabilitation of most of the principal structures, the present O & M charges of $0.35 per AF are felt to be adequate. The improved structures should alleviate the continuing problem of maintenance with the existing spillway.

LAND

Introduction

The additional firm water supplies made available through this project would be used to supplement supplies on existing irrigated lands or to provide water for new lands. The division would depend on how the water could be marketed. Present copping patterns, yields and marginal values associated with furnishing a full water supply to project lands are established in the following section.

Cropping Patterns

CROPPING PATTERN, YIELDS AND MARGINAL VALUES
RCWUA SERVICE AREA

	Cropping Pattern 1/		Yields			
Crop	Acres	Percent	Partial Supply	Full Supply	Percent Increase	Marginal Value/Acr
Small grains	1,313	7.4	64 bu.	80 bu.	25	$22.81
Corn silage	497	2.8	12 tons	20 tons	67	96.54
Sugar beets	1,953	11.0	16.5 tons	19.5 tons	18	72.45
Dry beans	497	2.8	17 c.w.t.	20 c.w.t.	18	30.49
Alfalfa hay	4,845	27.3	3 tons	3.5 tons	17	23.08
Other hay	7,810	44.0	3 tons	3.5 tons	17	23.08
Pasture	835	4.7	4.8 Aum	6.0 Aum	25	5.19
TOTALS	17,750	100.0		Weighted Average		$29.84/ acre

1/ Source: Montana Department of Agriculture and Statistical Reporting Service, Carbon County, 1975.

Land Ownership

It is not known at this time if any water users or potential users would have lands in excess of 160 acres. This will be determined after selection of the final plan.

WATER

Water Supply

The yield of Cooney Reservoir cannot be precisely defined due to existing problems in evaluating water right release requirements. The present storage of the reservoir is 24,200 AF. Approximately 17,750 AF are sold annually for irrigation use. An increase in volume of 4200 AF establishes a new active storage of 28,400 AF. The increase in yield resulting from this additional storage has been determined to be 2000 AF per year on the basis of the most critical water period of 1960 to 1961. In the vast majority of years, approaching 19 years out of 20, the entire 4200 AF would be available for use.

Water Use

Based on the Cropping pattern presented above, an average crop consumptive use requirement of 1.25 AF/acre was computed for the lands served by Cooney Reservoir. The watershed depletion due to irrigation is estimated to be 1.60 feet, annually, to account for expected deep percolation and evapotranspiration by vegetation. Using an average efficiency for delivery and on-farm application of approximately 24% a total diversion requirement of 6.75 AF/acre is established. Historically, only 5.42 AF/acre has been made available resulting in an annual shortage of 1.33 AF/acre on presently served lands. Thus, the additional storage water made available could conceivably be used on existing lands.

Water Rights

The water rights for the Rock Creek project are documented in Chapter V (p. 12). An additional right would have to be obtained for the incremental storage above 27,400 AF; the original capacity with the flashboards in place. With a new active storage of 28,400 AF this would require a right for 1000 AF.

PAYMENT RESOURCES

The value of supplemental water has been determined to be as high as $29.84 per acre. It is arbitrarily assumed that the operator would be willing to apply a maximum of ¼ of this amount toward incremental water supplies, or $7.46 per acre. Based on a 1.33 AF/acre shortage, the maximum assessment assigned to the supplemental supplies would be $5.60 per AF. It is felt that a higher assessment would impede the marketability of the water supplies.

Since the funding sources are not apparent at this time, the financial program for the recommended irrigation alternative is presented in option No. 5, Table IX.1. This program is based on participation by the U.S. Bureau of Reclamation and the State of Montana and possibly private funding sources. This alternative assumes that P.L. 84-984 funds will provide a $890,000 loan at no interest for 40 years. A federal grant of $260,000 will be obtained; and the project will receive a state loan of $591,300 at 6% interest for 40 years. If the total repayment costs are divided equally between the new users and the existing users, the total cost to each group will be $7.77 and $2.19 per acre foot, respectively.

Many divisions of repayment are possible between new and existing users. For example, if the financial obligations for each unit of the available 21,950 AF of water are assumed uniformly by both new and existing users an annual assessment of $2.80 for each AF of water used would be required.

These alternatives do not include the additional $1.00 per AF that some of the users are still paying as principal on the original project. The final arrangements would be subject to negotiations between the users.

CHAPTER I

CONCLUSIONS AND RECOMMENDATIONS

Chapter I

CONCLUSIONS AND RECOMMENDATIONS

As a result of the investigations leading to this report, several specific conclusions and recommendations have been developed and are presented below.

CONCLUSIONS

The following conclusions bear out many of the initial reactions of the investigative panel of professional engineers which recommended this study.

1. The dam is presently inadequate to pass the Probable Maximum Flood and in the event of such an occurrence, the dam would be overtopped and would probably fail. This could lead to loss of life and would certainly cause extensive and irreparable damage to property and land downstream of the dam as evidenced in recent disasters. In addition, the replacement cost of Cooney Dam and the value of the water lost during reconstruction would far outweigh the cost of providing protection against this event.

2. The existing structures can be modified to meet modern day design standards. This can be accomplished by excavating a large emergency spillway northwest of the dam and raising the dam with the excavated material. This will provide both additional spillway capacity and storage. Together with these alterations, 4200 acre-feet of storage can be added to provide either additional yield or a flood surcharge storage.

3. The existing principal spillway is in poor repair as a result of both inadequate design and lack of periodic maintenance. Specific problems include undermining of the flip bucket, serious erosion in the plunge pool and drop structures and inadequate capacity of the lower drop structures to handle the 100-year flow. Regardless of any additional storage in the reservoir, the plunge pool and floors of drops 2 and 3 require rehabilitation. If there is no additional storage allocated to flood control, the lower two drops will have to be replaced with a concrete chute and stilling basin. Additional outflow channel capacity would also be required. If the increases in storage were allocated to flood control, thereby decreasing the maximum discharge, lesser repair at the base of the last drop is required to provide satisfactory operating conditions.

4. Liability for the cost of the repairs and new construction lies both with the private water users and the public represented by state and federal governments. The Rock Creek Water Users were not provided with an adequately designed and completed structure even under 1936 standards. In particular, the spillway was never finished. Further, there are beneficifiaries of flood control, recreation and fishing that should contribute to the rehabilitation by way of public funds.

5. The proposed modifications can be accomplished in an economical manner if costs are shared among all the beneficiaries.

RECOMMENDATIONS

The following recommendations are defined to establish future courses of action and the level of further study required.

1. It is recommended that modifications be undertaken at the earliest possible date to bring Cooney Dam into conformance with present dam safety standards. This includes, at the very least, the excavation of an emergency spillway and raising the dam to provide adequate protection in the event of a flood approaching the probable maximum event. In addition, repairs should be undertaken on the existing spillway to prevent the loss of any of the major structures which are badly deteriorated.

2. It is recommended that the irrigation alternative be selected for final design and construction. This configuration results in the lowest cost to the water users and provides additional water for supplemental and/or new irrigation in an area where late season supplies are often limited.

3. An immediate effort should be made to establish both sources and amounts of available funding. In particular, the contribution of the state either in the form of loan, grant or both must be quantified. P.L. 984 funding offered by the Bureau of Reclamation appears to be the most attractive funding alternative if matching funds of approximately 50 percent can be obtained from non-Federal sources. Since the loan application and approval process can take 2 years, outside funding sources must be immediately identified so that project development can be initiated.

4. Prior to final design and construction, an in-depth geologic investigation of the existing dam must be undertaken to assure that increasing the height and possibly the normal water surface would not endanger the embankment. In particular, an investigation into the foundation stability of the dam must be performed to assure that there is adequate strength to withstand any increase in normal water levels.

Also, the slope stability of the dam should be analyzed under the proposed higher water levels even though the material being used to raise the dam will probably increase this factor. Both of these analyses will require a drilling program to determine the characteristics of the existing embankment.

5. Prior to final design and construction, a model study of the spillway should be undertaken to verify the design computation, establish the most economical dimensions of new structures and set upper limits of capacity on existing structures. In particular, analytical techniques are not adequate to describe the action of the flip bucket and plunge pool or the capacity of the lower two drop structures once flow becomes highly turbulent, air-entrained, and affected by standing waves. These actions must be verified by model studies.

   In the case of the plunge pool, adequate volume must be provided so that the riprap lining will not be eroded out of the basin and transported through the drop structures below. This could cause serious structural damage. Presently, however, there are only vague guidelines for establishing the size of the plunge pools and this is not felt to provide adequate protection for a project of this magnitude.

   If the flood control alternative is given further consideration, the lower two drop structures should be modeled to establish their maximum capacity for allottment of flood control storage. If, for example, the capacity of these structures was found to be 3,000 cfs, approximately 1,700 acre-feet of the additional 4,200 acre-feet of storage could be provided for increase in the conservation storage and sold as irrigation water. An exact determination of this capacity would provide a much more accurate and economical allocation of the additional storage.

6. In order to optimize the life of the structures of the principal spillway, it is recommended that the Rock Creek Water Users Association and the Department of Natural Resources and Conservation enlist the SCS Snow Survey Unit to prepare an operation plan for Cooney Reservoir. There are currently two snow survey sites in the drainage and adequate data are available to develop such a plan. The wise operation of the reservoir will, in general, minimize use of the spillway and prolong the life of the project.

CHAPTER II

GENERAL INFORMATION

Chapter II

GENERAL INFORMATION

DESCRIPTION OF THE DRAINAGE AREA

Cooney Dam is located on Red Lodge Creek below its confluence with Willow Creek in Carbon County, Montana. Red Lodge lies on the southeast edge of the basin as shown in Figure II.1. The drainage area above the dam is approximately 200 square miles. Of this area, 143 square miles is above the reservoir on Red Lodge Creek. The Willow Creek watershed constitutes an additional 53 square miles of contributing watershed. The remaining 4 square miles is made up of the reservoir area and small drainages which enter the reservoir below the gages but above the dam.

BASIN GEOLOGY

Red Lodge Creek and Willow Creek drain a part of the north slope of the Beartooth Mountains. Approximately 22 percent of the basin is in this topography. Geology ranges from preCambrian on the Beartooth plateau to Madison which is exposed on the slope. Vegetation is mostly forest in this area. The largest part of the basin, approximately 78 percent consists of rolling plains underlain by the Fort Union Formation with some areas, particularly in Willow Creek, underlain by terrace gravels. Recent alluvium is found along all of the major stream channels. Range type vegetation is typical of this region.

CLIMATE

Average precipitation in the study area is 22.0 inches per year but ranges from less than 16 inches per year at the dam to over 30 inches per year in the high mountain areas. Major storm paths in this region are generally from the east and northeast with large precipitation volumes caused by orographic uplift over the Beartooth Mountains. Much of the precipitation in the higher elevation falls as snow and is stored in the snowpack through the winter. It is released as runoff during the late spring months.

EXISTING SITUATION

Cooney Dam and Reservoir is part of the Rock Creek project owned by the Department of Natural Resources and Conservation (DNR & C) and located in Carbon County, Montana. This project was completed in 1937 and was financed by the Public Works Administration and State Water Conservation Board (SWCB) funds. Cooney Dam is an earthfill structure located on Red Lodge Creek as shown in Figure II.1.

Maximum height is 97 feet, crest length is approximately 2,260 feet, and the total capacity at the spillway crest elevation of 4,250 feet msl was 27,400 acre-feet at the time of construction. Since the late 1940's the flashboards located in the inlet of the spillway have not been used and the total capacity of the reservoir is now considered to be 24,195 acre-feet at a spillway crest elevation of 4246' msl.

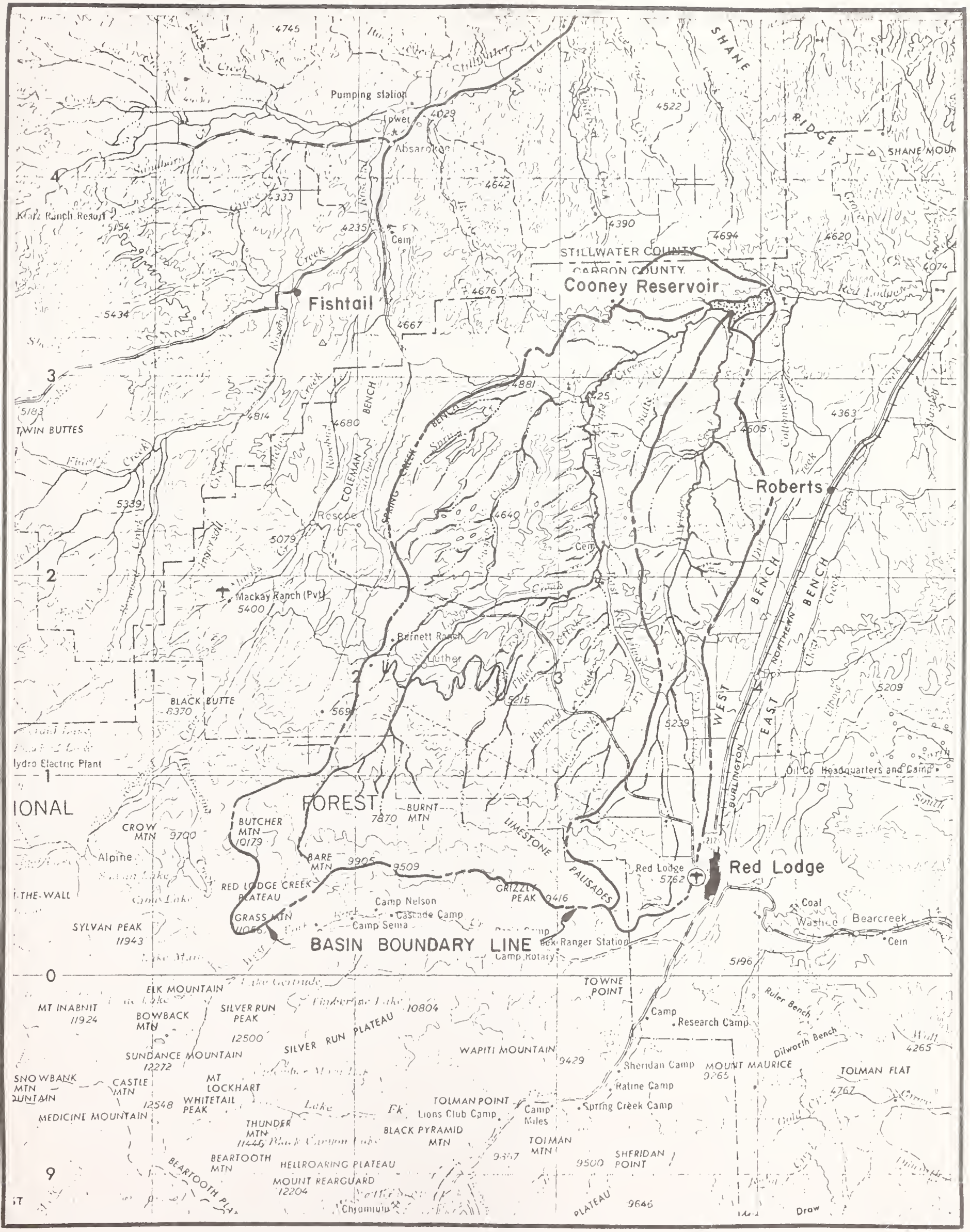
An inspection of the spillway at Cooney Dam was initiated in 1976 by DNR & C. A panel of three professional Engineers was selected to evaluate the existing structure and recommend a future work program to the DNR & C and the Rock Creek Water Users Association who operate and maintain the project. Presently, the spillway consists of: an earthen approach channel approximately 585 feet long; a concrete spillway dropping approximately 33 feet with a flip bucket at its base; a naturally excavated plunge pool below the flip bucket; and five concrete drop structures. In general, the panel found this configuration inadequate under existing spillway design standards and in a poor state of repair. The recommendations of the Board are presented below in their entirety.

It was recommended that:

1. (a) The Montana Department of Natural Resources and Conservation recognize publicly that the State of Montana did not provide adequate engineering design or construction in building the original Cooney Dam spillway; (b) they also recognize that the Rock Creek Water Users Association would reasonably have expected the original State Water Conservation Board to have done so.

2. The Montana Department of Natural Resources accept the responsibility and take the initiative to find proper funding so that the Cooney Dam spillway may be thoroughly studied by a competent engineering organization to be employed by the Department. Such a study should include thorough geologic investigations and should be carried out in terms of the hydrological and meteorological data currently available. It should take into account present-day societal concerns regarding dam safety, all appropriate legal requirements, and modern engineering knowledge and practice.

3. As the department determines from such an engineering study the acceptable alternatives available and their costs, negotiations can be initiated to determine possible sources of revenue and methods of financing.



VICINITY MAP
COONEY RESERVOIR
FIGURE II-1

4. A plan of financing the work be adopted which properly takes into account all beneficiaries of the Cooney Dam project, the most obvious of whom are the Rock Creek Water Users Association, the fishermen and other recreationalists using the Cooney Reservoir, the owners of land and other property downstream from the dam who benefit from control of flood flows during most years, and the State of Montana.

CHAPTER III

ROCK CREEK WATER USERS ASSOCIATION

Chapter III

ROCK CREEK WATER USERS ASSOCIATION

HISTORY

The following excerpts are taken directly from the Water Resources Survey, Carbon County, Montana as published by the State Water Conservation Board (DNR & C) in 1965:

> "The Rock Creek Water Users Asssociation was incorporated under the laws of Montana on June 27, 1935 with authority to issue 50,000 shares of stock at $1.00 par value. The Association is managed by a board of five directors and employs a dam tender who cooperates with the local water commissioner in the distribution of project water. Originally, there were 432 water purchase contracts, agreeing to purchase 31,584 acre feet of water which were approved by the association, the Water Board, (DNR &C) and the finance dividion of the P.W.A. The project was first operated during the irrigation season of 1937 and has been in continual operation since that date."

> "The Rock Creek Project consists of the construction of two reservoirs and some small canals. The largest reservoir, known as Cooney Reservoir, is located 8 miles west of Boyd on Red Lodge Creek. The other reservoir, Glacier Lake, is located near the headwaters of Rock Creek at an elevation of 10,000 feet, about 25 miles southwest of Red Lodge. To improve the water supply to Cooney Reservoir, the Point of Rocks canal was constructed which diverts water from Rock Creek to the West Fork of Rock Creek. From the West Fork of Rock Creek the water is carried in the Pryde Ditch to Willow Creek, which flows into Cooney Reservoir. To furnish additional water to the water users and to the Cooney Reservoir, an enlargement was made in the carrying capacity of the Finn and Cottonwood Canals."

"Plans for this project were first submitted to the State Water Conservation Board (DNR & C) on February 7, 1934, only a few days after the Board was created. This was the first Water Board project approved and financed by a loan and grant from the Public Works Administration. All the pioneering work of setting up a plan for an entirely new form of financing irrigation projects had to be worked out with the construction of this project. Among some of the legal documents to be drafted were such major forms as Articles of Incorporation of the Water Users Association, formation of bonds, bond transcripts, water purchase contracts, and water marketing contracts. This took a great deal of time and study, but it paved the way for other water board projects which were to be constructed later."

SUMMARY OF STATUS OF REPAYMENT CONTRACTS

The total project cost of $837,000 was financed by a Federal Public works Administration loan and grant of $712,000, together with $120,000 from the State of Montana and $5,000 from the Rock Creek Users Association. Montana Water Conservation Revenue Bonds were issued and a Trust Indenture executed with the contract between the State Water Board (DNR & C) and the Rock Creek Water Users and Water Purchase Contracts made with individual water users assigned to a Trustee to secure the loan. The project also included the construction of the rock-fill dam upstream enlarging Glacier Lake.

In return for the right to use any active storage water from Glacier and Cooney Reservoirs, estimated in 1935 at 31,500 acre-feet/year, the Water Users agreed to pay $31,500 on December 15,1937, and each year thereafter through December 15, 1975. The Water Users also agreed to pay on December 15 of each year, starting in 1937, and continuing every year thereafter during the useful life of the Project, the operating costs of the project as determined by the Board for the following year. Such operating costs are defined to include "all costs of the maintenance, repair, operation and necessary alteration of the project, and all costs incurred by the Association or the Board (DNR & C) in the distribution of water from the project." The determination by the Board (DNR & C) of the annual amounts necessary to cover such costs was agreed to be final, conclusive, and binding upon the Association and the water purchasers. The agreement further provided that the Board (DNR & C) retained the right to terminate the contract in the event that the Association should be in default.

The actual terms of repayment were considerably different than the above. The DNR & C has allowed each water user to pay $1.00 per acre-foot contracted for a period of 40 years. This amount is called the principal. At present 274 water purchase contracts are held by 200 water users. Typically, 17,750 acre-feet of water are sold under these contracts. This water is all distributed through private diversions and canals.

A summary of the assessment for the November 1, 1976 to November 1, 1977 season is presented in Table III-1.

Table III.1

1977 IRRIGATION SEASON ASSESSMENTS
ROCK CREEK WATER USERS ASSOCIATION

Item	Cost ($) Per Acre/ft.	Total Cost ($)
Principal 1/	$1.00	$11,595.00
Regular O & M	.25	4,471.89
Special Assessment 2/	.10	1,792.50
Repairs Assessment 3/	1.00	17,993.75
Total	$2.35	$35,853.14

1/ At present 88 users have repayed the principal outstanding and are not assessed this $1.00.

2/ This Special Assessment (Newkirk Settlement) involved purchase of an adjacent farm which was damaged by operation of the spillway. This assessment will be satisfied after the 1978 charges are paid.

3/ This is a temporary assessment for repair of the spillway and replacement of Point of Rocks flume.

The state has historically paid a portion of unusual annual operating and maintenance costs and assessed a charge to recover the expense over a period of years. The most recent repayment contracts have had a variable interest rate based on the prime rate at Seattle First National Bank.

CHAPTER IV

LANDS

CHAPTER IV

LANDS

ACREAGE IRRIGATED

Most of the water sold under this project is used as a supplemental water supply to the landowners holding decreed water rights from Rock Creek. However, there are four water users purchasing water from the Association for the irrigation of 314 acres that have no other water supply. The total irrigated acreage furnished a supplemental water supply under this irrigation project is approximately 17,000 acres.

LAND OWNERSHIP

All lands currently utilizing storage water for supplemental irrigation are held in private ownership. As mentioned previously, approximately 200 individuals normally purchase water each year.

A study has not been made to determine what amount of water is provided to lands held in greater than a single beneficial ownership of 160 acres or 320 acres by man and wife. This determination would involve considerable research since the lands on which the storage water is used are not specifically identified in the assessment process. The average water puchase is 85 acre-feet and the maximum purchase is 525 acre-feet.

CROPPING PATTERNS AND YIELDS

Since production records are not kept specific to the irrigated acreage of the Rock Creek Water Users Association, it is difficult to develop cropping patterns and yields information. Thus, Carbon County statistics as developed by the Montana Department of Agriculture and Statistical Reporting Service, (USDA) for the year 1975, are adopted. These values should adequately represent the area irrigated and are summarized in Table VIII.1. Reference should be made to Chapter VIII, Page 40.

CHAPTER V

WATER

Chapter V

WATER

WATER REQUIREMENTS

There have been no studies made of the water needs or operations of the Rock Creek project, as such; however, the Type IV survey for the Wind-Bighorn-Clarks Fork River basins as prepared by the USDA Soil Conservation Service does give an indication of water needs. Considering watershed 14c-9, Red Lodge and Rock Creek, (Table II.8, Montana Supplement), the SCS has identified an irrigation depletion of 1.6 acre-feet/acre. Table IV.6 of the same report identifies a diversion requirement of 6.75 acre-feet/acre and a present diversion of 5.42 acre-feet/acre resulting in a need for 1.33 acre-feet/acre of additional storage for watershed 14c-9. A specific study of how Cooney Dam and Reservoir may affect the present and potential needs and uses of the Rock Creek Water Users has not been completed and is beyond the scope of this report.

WATER RIGHTS

Water rights listed for the Red Lodge Rock Creek project as documented in the Carbon County Water Resources Survey are as follows:

Water decreed to Henry and Bertha Dahlem for Willow Creek, dated 5-1-96 for 150 miner's inches. (Ref: Willow Creek Decree Case #2484, Clerk of Court's Office, Red Lodge; and Deed Book 53, page 145, Clerk and Recorder's Office, Red Lodge, Montana.)

Decreed to G.W.Robertson from Willow Creek, date 5-1-96 for 100 miner's inches. (Ref: Willow Creek Decree Case #2484, Clerk of Court's Office, Red Lodge; and Deed Book 51, page 24, Clerk and Recorder's Office, Red Lodge, Montana.)

An appropriation by the State Water Conservation Board from Rock Creek, date 5-10-34 for all unappropriated water (Glacier Lake Reservoir). (Ref: Book 15, Misc. page 352, Clerk and Recorder's Office, Red Lodge, Montana.)

An appropriation by the State Water Conservation Board from Red Lodge Creek, date 5-10-34 for all unappropriated water (Cooney Reservoir). (Ref: Book 15, Misc. Record, page 352, Clerk and Recorder's Office, Red Lodge, Montana.)

RESERVOIR OPERATION

A reservoir operation study was undertaken, initially, in an attempt to determine the existing firm yield of Cooney Reservoir and, secondly, to establish what increase in yield would accompany the proposed increase in storage. Operating the reservoir to establish the existing yield requires detailed information including bypasses required for downstream water rights established prior to the storage project. After considerable literature review and discussion with the Water Commissioner for Rock Creek, it could not be determined what these required bypass flows were. As a result, an incremental analysis was performed to determine the increase in yield as a function of increase in storage rather than establishing absolute yields for the existing and proposed conditions.

Several considerations entered into the operation study. Included are: adjustment of flow data; reservoir evaporation; distribution of releases for irrigation use; selection of critical period; and relation of critical period flows to long term record. Streamflow data were taken from the USGS gaging station 06212500, Red Lodge Creek below Cooney Reservoir, and adjusted for historic changes in storage of the reservoir. Monthly data were used. Reservoir evaporation was estimated from data in the Billings area and adjusted for average temperature differences to account for decreases in temperature due to increases in elevation. Release distributions were estimated using average monthly irrigation water requirements presented by the SCS in "Irrigation Guide for Montana." The critical period from 1959 to 1962 was used for this operation study. This 4-year period contained 2 consecutive very low years, 1960 and 1961. These 2 years exhibited 1/3 the average flow and were very severe compared to all other years. Inspecting the adjusted record and comparing it with storage availability, it appears that this was the only period during which carryover storage has actually been required.

The results of the operation study establish that, with an increase in storage of approximately 4,200 acre-feet, as presented in Chapter VI, "Plan of Development", an increase in yield during the critical period of 2,100 acre-feet can be expected. This is the case even if increased downstream releases are required. The historic record indicates, however, that the full amount of storage increase, 4,200 acre-feet, can be provided at least 9 out of 10 years and probably 19 out of 20. Thus, water service contracts can reasonably be sold for the total incremental storage capacity.

WATER QUALITY

At present, Cooney Reservoir has little effect on water quality and the spillway modifications should reduce erosion and decrease sediment concentrations downstream. Although the surface area subject to evaporation will increase approximately 100 acres, increased concentrating effects will be minimal.

CHAPTER VI

PLAN OF DEVELOPMENT

Chapter VI

PLAN OF DEVELOPMENT

PHYSICAL PLAN

The selection of a physical plan was dictated by the requirement that the structure have the capacity to pass the Probable Maximum Flood (PMF) without failure and the 100-year flood without damage. These criteria led to a design incorporating two major features. The first includes the excavation of a large emergency spillway adjacent to the existing principal spillway. The excavated material will be placed on the upstream face of the dam embankment, raising the crest elevation and providing the necessary freeboard during the PMF. In addition, the storage of the reservoir will be increased by 4200 AF which can be allocated to either an increase in the conservation pool or flood surcharge storage. The second feature of the physical plan is the rehabilitation of the existing principal spillway to provide adequate hydraulic capacity for passing the 100-year flood.

Two alternatives are presented which differ in the degree of rehabilitation of the principal spillway resulting from the allocation of the increased storage capacity. One option assumes that the normal water surface (NWS) will be increased by 5 ft. and the additional storage will be allocated to either irrigation use or a permanent recreation pool. Either of these operating plans result in a 100-year flood peak which exceeds the capacity of several of the principal spillway structures. If the 4200 AF of storage is allocated to a flood pool, the 100-year flood peak is routed downward and most of the structures will require only rehabilitation, not replacement. The major features are shown in the site plan (Exhibit No. A-1) found in Appendix A.

GEOLOGIC INVESTIGATION

Northern Testing Laboratories, Inc., (NTL) was retained to conduct a geologic investigation of the Cooney Dam Spillway project area. This consisted of drilling and boring test holes and evaluating site materials in terms of: methods of excavation required; suitability of excavated materials for use in raising the dam; and slope and foundation stability of the materials. Much of the following discussion is summarized from NTL's report. The report, in its entirety, is presented in Appendix B.

Site and Subsoil Conditions

The emergency spillway was initially investigated about 1,000 feet north and west of the northwest abutment of Cooney Dam. After drilling, this location was not found feasible due to massive amounts of sandstone excavation. Enlargement of the existing spillway to about 300 feet wide, was later chosen as the most cost effective alternative. However, the initial information was used in overall assessment as presented in the following paragraphs. The local topography consists of grass-covered rolling holls. Several sandstone bedrock outcrops are evident in the existing spillway and in the local drainages.

The general subsurface profile along the initial spillway location (Drill holes 1 through 3) consists of a thin layer of sand, underlain by an upper sandstone layer, a layer of shale, and a lower sandstone unit. These materials are described in detail by the boring logs found in Appendix B, and are generalized as follows:

1. Silty Sand. This material was encountered on the surface and extends to depths of about 1 to 2 feet. It is generally fine-grained, compact, and contains considerable organic material.

2. Upper Sandstone Layer. This layer extends to depths of about 4 to 8 feet (elevation 4,272 to 4,266). It is generally moderately weathered, poorly cemented, and fine-grained. Excavation can be accomplished with conventional equipment.

3. Shale Layer. Underlying the sandstone, a shale was encountered to depths of about 20 to 24 feet (elevation 4,256 to 4,247). Standard penetration resistance (N) values ranged from 39 to more than 100 blows per foot. This material is generally composed of clay-sized particles, although occasional thin lenses of silt-stone and sandstone were encountered. The shale will be subject to moderate deterioration upon exposure to cycles of wetting and drying. It is expected that, generally, excavation of this material can be accomplished with conventional equipment, although heavy rippers will be required. Isolated, well-cemented siltstone or sandstone zones within the shale may require special excavation techniques, and localized blasting may be preferred.

4. Lower Sandstone. This material was encountered below the shale and extends to the depth of the borings. N values in this material were all in excess of 100. It is extremely well-cemented and has high strength. It is doubtful that it can be excavated with conventional equipment; blasting will probably be required.

In the existing lower spillway (D.H. #4), interbedded layers of shale and sandstone were encountered to the depth of the boring.

Groundwater was not encountered in any of the test borings at the time of the investigation (August 20, 1977). It is expected that, unless the reservoir rises to near the spillway elevation, groundwater will not affect construction.

Excavation Slopes

With the proposed spillway alignment, cuts up to 30 feet will be required. Most of the excavation will be in the shale or sandstone bedrock, and since these materials have a high strength, temporary excavation slopes can be relatively steep. Two conditions will affect long-term performance of cut slopes in the bedrock materials, and will require flatter permanent slopes. First, a thin zone near the surface of exposed cuts will be subject to slaking -- a softening and strength loss. If the slopes are too steep, this material will migrate to the base of the cut, resulting in flatter slopes. Second, erosion from runoff down the slopes will be severe if the slopes are too steep. Inspection of natural slopes in the area, and slopes in the existing spillway, illustrate these conditions.

Analysis indicates that temporary slopes in the bedrock will be stable at 3/4:1 (horizontal to vertical), but permanent slopes should be flattened at 2:1.

Materials Evaluation

A general analysis of the suitability of the excavated material for use in raising the dam was undertaken. The results are presented below.

Silty Sand and Upper Sandstone Layer. When excavated, these materials will generally be granular and in the sand and gravel size ranges. This material could probably be used as permeable drain material.

Shale Layer. It is expected the shale will generally break down into small particle sizes when excavated and recompacted. It should be suitable for impermeable liner or core material. Isolated sandstone and siltstone layers within the shale may not break down and would not be suitable for this use.

Lower Sandstone. If this material is excavated by blasting techniques, it may be suitable for riprap. Additional studies will be required when the sandstone is excavated to determine its durability.

A sandstone quarry is located near the southeast abutment of the dam. This material has been successfully used as riprap at several locations around the dam.

All of the materials encountered will be suitable for use in properly designed stabilizing berms. Additional study will be required for all material uses, after details of the dam modification are determined.

Relationship of Excavation Volume to Fill Volume. No specific tests were made of the in place density and optimum compacted density of the shales to be used for fill on the dam. However, it is expected that the ratio of excavation to fill will be close to 1:1 as the shale will excavate with a considerable amount of coarse material which will lessen compaction. For estimation purposes a 1:1 ratio was used. This design feature will be refined during preconstruction investigations.

Recommendations

From the above analysis, two major conclusions were drawn.

1. Excavation slopes should be no steeper than the following, or be shored:

Material	Temporary Horizontal to	Permanent Vertical
Silty Sand	1:1	2:1
Shale or Sandstone	3/4:1	2:1

2. Special excavation techniques should be anticipated at isolated locations within the shale layer. Blasting should be anticipated when excavations extend into the lower sandstone layer (See Exhibit A-8).

FLOOD HYDROLOGY

The Red Lodge Creek drainage experiences large seasonal variations in flow above Cooney Dam. Most large flows in the past have been the result of a combination of rainfall and snowmelt but it appears that rainfall has always been the primary contributor. Timing of these peaks has been May and June which are two high precipitation months and correspond to the period of time when snowmelt is generally occurring.

Flood Frequency Analysis

Two USGS gaging stations, Red Lodge Creek above Cooney Reservoir near Boyd, and Willow Creek near Boyd, account for 98 percent of the drainage area above Cooney Reservoir. Flood frequency analyses were performed on the annual peak flow series for these two stations using procedures recommended by the United States Water Resources Council. In short, this method recommends the use of the Log-Pearson Type III distribution with the skew coefficient dependent on the number of years data are available. In this case, skews were weighted using both station and statewide values. The results of these analysis are presented in Table VI.2.

Table VI.2

FLOOD FREQUENCY DATA FOR FLOODS ABOVE COONEY DAM

Return Period (years)	Peak Flows (cfs)	
	Red Lodge Creek Above Cooney Reservoir near Boyd	Willow Creek near Boyd
50	3,160	1,660
100	3,880	2,130
500	5,860	3,530

Source: HKM Engineers Using U.S.G.S. Revised Data.

Assuming that the combination of these two stations represents the flood frequency relationship for the entire watershed, a 100-year flood of 6,010 cfs and a 500-year flood of 9,390 cfs would be expected. These flows are somewhat high for the combined Red Lodge Creek and Willow Creek watersheds. On the other hand, not all of the area contributing to the reservoir is reflected by these stations. Therefore, these statistics will be used for design purposes in this investigation.

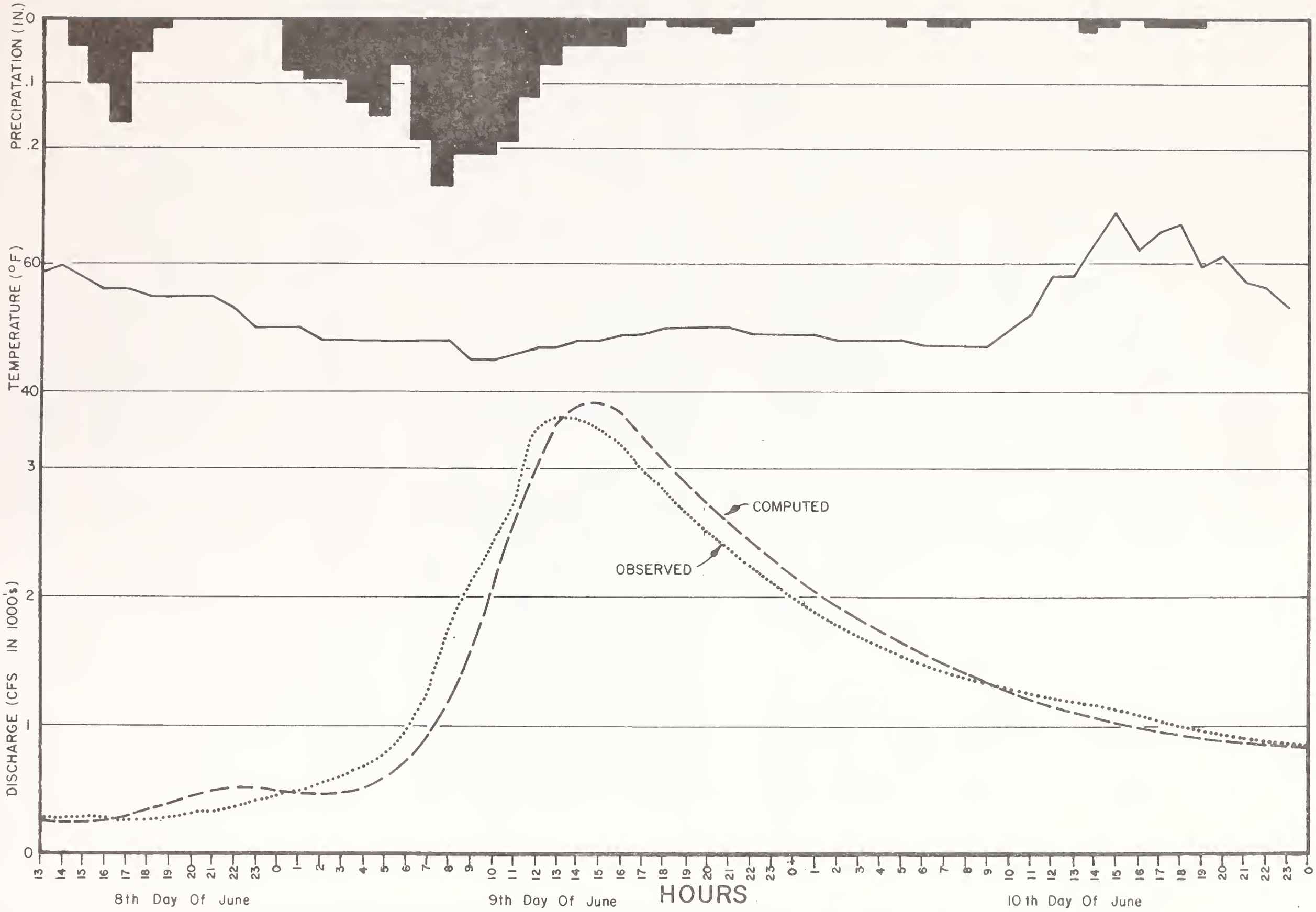
Derivation of Inflow Hydrographs

The approach taken to simulate hydrographs for design floods in this analysis was to derive unit hydrographs for the two major tributaries and apply design storms to these unit graphs to produce the design floods. To aid in this analysis, the HEC-1 computer program was used. This program simulates flood runoff from rainfall and snowmelt based on given loss rate functions and unit hydrograph characteristics. A calibration of the program is required to derive the best unit graph variables so that an historic flood is simulated with acceptable results.

For Red Lodge and Willow Creeks above Cooney Reservoir, the flood which occurred June 8 to 10, 1968 was chosen for use in the calibration process. This event was marked by a single peak flow in both drainages of relatively high magnitude (30-year recurrence for Red Lodge Creek and 3-year recurrence for Willow Creek). Precipitation data for this period were collected for the Roberts, Red Lodge and Fishtail stations. These locations have daily precipitation data which were used to determine storm volumes. Hourly precipitation data from Bridger and Reedpoint were used to distribute total storm precipitation through time. In addition to rainfall, snowmelt was considered. Snowpack data were available for this period for the Grizzly Peak snow survey station operated by the Soil Conservation Service. This station is located near the top of the drainage of Willow Creek. Due to lack of data on dewpoints, wind velocities and solar radiation, the degree day method was used to stimulate snowmelt. Daily maximum and minimum temperatures collected at Red Lodge were distributed hourly based on data from the Billings Airport. The temperatures were then lapsed at a rate of 3° per 1,000 feet to the elevation of the reservoir. This lapse rate was found to approximate that which exists during storm events in the area. Finally, hourly streamflow data were taken from USGS recorder tapes as stages and converted to discharges using an appropriate stage-discharge relationship. Reconstituted and recorded hydrographs for the June 8 through 10, 1968 event are shown in Figure VI.1 along with precipitation and temperature. A storm which occurred June 6th through the 10th, 1974 was also simulated with acceptable accuracy.

The reconstitution study, discussed above, illustrated one important point to be considered in deriving the design floods. Snowmelt had very little contribution during the storm due to the low temperatures accompanying the precipitation. An investigation of high runoff events in 1967 and 1975 revealed similar temperature patterns during the storm which generally accompany large storms and that snowmelt during the storm will be small. The HEC-1 model did not have the capability of accounting for rain-induced snowmelt without also demanding data on dewpoint, solar radiation and wind movement. It is not expected that the quantity and distribution of snow during the synthesis of the design flood would be critical parameters.

Once the unit hydrograph parameters were determined, a design flood of 100-year recurrence interval was derived. The process involved was to select a design storm, in this case the 24-hour, 100-year storm, and adjust loss rates until the known peak discharge was obtained from the unit hydrograph simulation process. The 24-hour, 100-year rainfall over the watershed amounted to 3.87 inches. Distribution of this volume in time was arbitrarily selected as the usual Standard Project Precipitation distribution used by the Corps of Engineers.



FLOOD RECONSTITUTION FOR JUNE 8 TO 10, 1968, RED LODGE CREEK

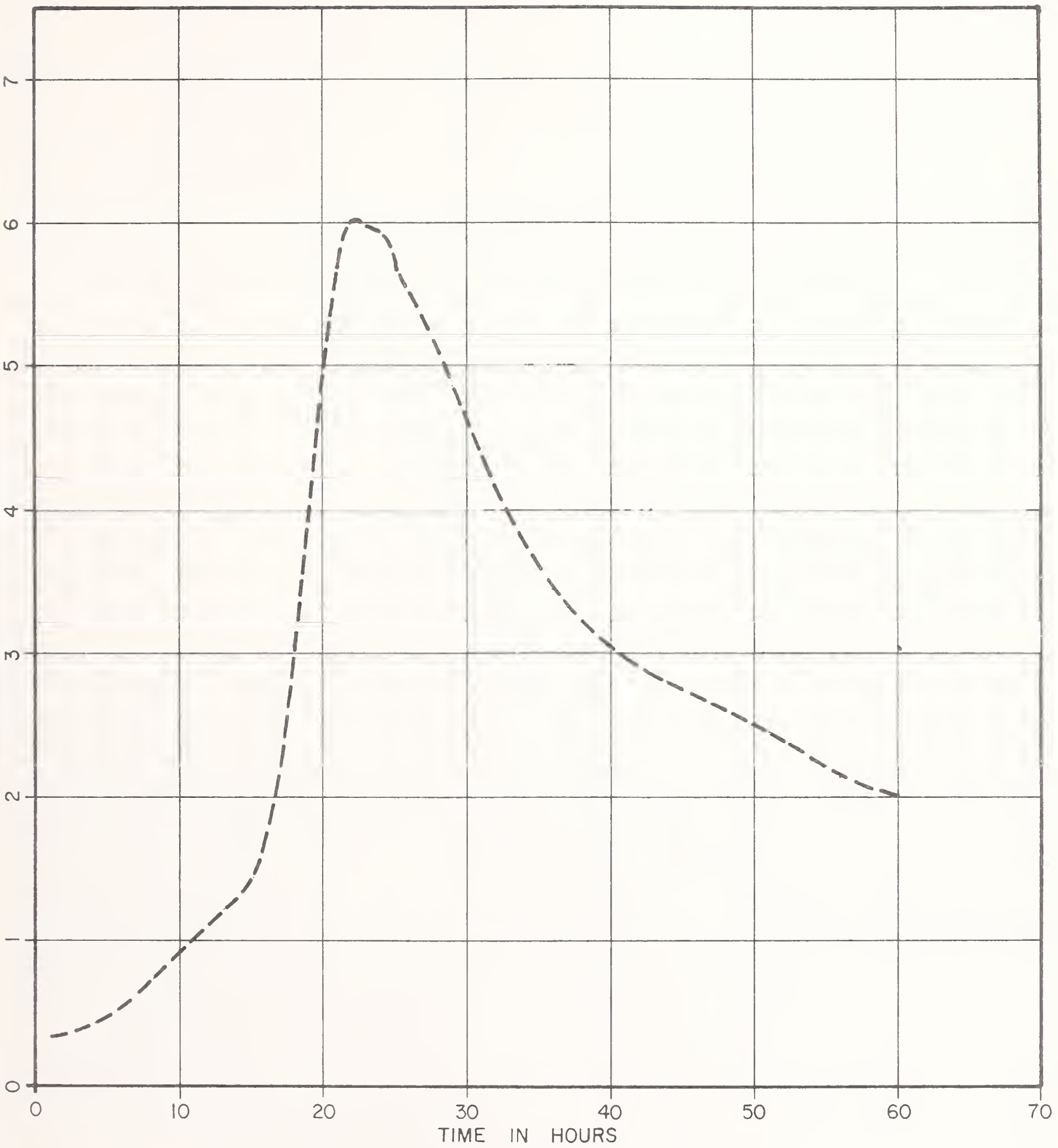
FIGURE VI - 1

Since, in general, the 100-year precipitation event does not result in the 100-year runoff, adjustment of infiltration losses to reproduce the 100-year peak was required.

The Probable Maximum Flood (PMF) was derived using probable maximum precipitation, minimum loss rates and the unit hydrograph derived in the earlier reconstitution studies. Probable maximum precipitation has been estimated by the U.S. Bureau of Reclamation (U.S.B.R.) based on a procedure using historic storms in the western U.S. A map of this analysis is presented in Design of Small Dams from which 6-hour PMP for the Red Lodge Creek area of 7-inches (point value) can be obtained. To verify this value conversations were undertaken with the U.S.B.R. Hydrometeorologist in Denver. As a result of this conversation, the 6-hour PMP was further increased to 8.5 inches for a point value. In reviewing other sources, the Weather Bureau Technical Paper 38, which is the basis for Corps of Engineer data, presents somewhat higher values for PMP, particularly on a 6-hour basis. On the overall 24-hour storm, however, the total volumes are quite close. The recent U.S.B.R. estimate was used in this analysis. This resulted in the following determinations: a maximum 1-hour value of 3.63 inches; a maximum 6-hour precipitation of 7.4 inches; and a 24-hour precipitation of 13.17 inches. This is based on corresponding point values, which are adjusted for areal reduction and distributed through time.

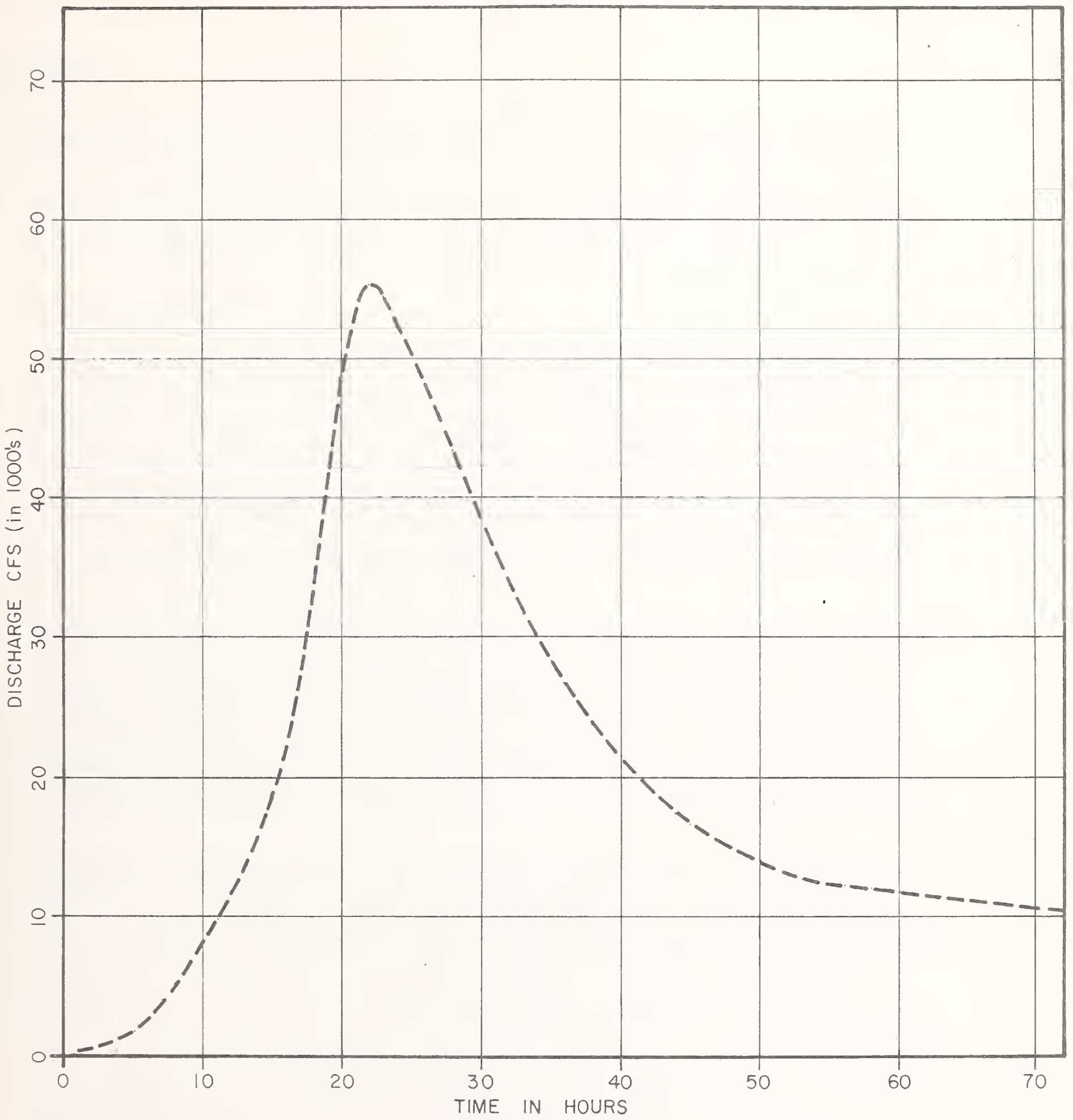
Loss rates during the PMF correspond to a wet antecedent condition with no initial large loss. Analyses of the largest two flood events (1967 and 1975) led to historic estimates of average loss rates of 0.12 and 0.16 inches per hour, respectively. For synthesis of the PMF, a constant loss rate of 0.10 inches per hour was established. This value is less than the historic recorded statistic and is somewhat less than the minimum rates suggested by the U.S.B.R., based on soil types. The selected rate should account for any snowmelt not simulated by the model. snowpack and temperature sequences correspond to those used during synthesis of the 100-year flood. Since, historically, no snowpack during the spring season has been recorded below 6000 feet, none was used in this synthesis. In addition, the temperature sequences used are felt to approach the maximum consistent with large, general type storms.

The peak flow derived, using the procedures and data described above, was 55,300 cfs, a slightly higher peak would be obtained using the higher precipitation from TP38.



100 YEAR INFLOW HYDROGRAPH
FOR COONEY DAM

FIGURE VI-2



PROBABLE MAXIMUM FLOOD HYDROGRAPH
FOR COONEY DAM

FIGURE VI-3

DESIGN

The project design has two major features: construction of an emergency spillway with concurrent raising of the dam structure; and rehabilitation of the existing principal spillway. These actions will allow the dam structure to meet dam safety criteria for passage of probable maximum flood flows while minimizing the cost of repair and/or facility additions. This has been achieved by using, wherever possible, the existing structure.

Design Rationale

There were two levels of concern in this preliminary design which influenced the selection of design criteria. For the emergency spillway, the Probable Maximum Flood (PMF) was used to size the channel. Use of the PMF was dictated by the size of the dam and the expected consequences of failure. The emergency spillway should pass the PMF with some minimum freeboard and, during the PMF, the integrity of the principal spillway should also be assured. For rehabilitation of the principal spillway, the 100-year flood was the design discharge. This structure has been re-designed so that all of the features can accommodate the routed 100-year flood without damage.

Emergency spillway design criteria is dictated by present standards which require that the public safety be insured. These criteria have resulted from the failures of dams in the west and the recent occurrence of very large storms, in particular the 1964 flood in Montana, the 1974 flood in Rapid City, South Dakota and the 1976 flood in the Big Thompson River Basin, Colorado. In addition to public welfare, the enormous expense of replacing structures at today's costs dictates a high degree of protection against destruction by large, infrequent events.

Implementing requirements for safety and economic protection, various alternative plans were evaluated which could fulfill the design criteria while remaining cost effective. Many design schemes were investigated before establishing the two alternatives presented here. These were found to be the most economical method of satisfying the design criteria. The two proposed alternatives both utilize the same basic emergency spillway design. The difference lies in degree of rehabilitation proposed for the principal spillway. In the irrigation and/or recreation alternative, a permanent increase in active storage is proposed. This requires more extensive rehabilitation of the principal spillway in the area of the lower two drop structures and the outflow channel as a result of higher 100-year flood flows. The flood control alternative provides the additional storage as flood surcharge and, consequently routes the 100-year flood to a reduced level for which the majority of the existing spillway structures are adequate, requiring some rehabilitation.

Emergency Spillway and Dam Enlargement

The proposed emergency spillway is located immediately adjacent to the existing principal spillway as shown in Exhibit A-1.

The channel is designed to be 310 feet wide at its base with 3:1 side slopes. The bottom slope of the channel is 0.2% from station 0+00 to 6+00. From 6+00 the slope increases to 0.6%. The spillway will discharge into a small drainage north of the dam. The peak design flow is 52,000 cfs. During the PMF, channel velocities greater than 14 feet per second (fps) will be realized. The plan and profile for this spillway are shown in Exhibits A-1 and A-2.

To prevent the emergency spillway from operating under normal conditions a fuse plug levee will be constructed across the channel. This will also serve as the county road. This fuse plug is designed to overtop only when flows exceed the 100-year flood discharge. The elevation of the lowest point on the levee has been established at 0.5 foot above the maximum 100-year reservoir elevation. The profile and typical cross section of the fuse plug and road construction are presented in Exhibit A-6.

The volume of excavation from the emergency spillway channel is 188,600 cu. yd. of which 9100 cu. yd. are classified as rock. This material will be placed on the upstream face of the dam raising the crest 5.0 feet to an elevation of 4265.0 ft. msl. (Exhibit A-7). This elevation will provide a 4.7' freeboard at the maximum elevation of the PMF. This compares with a 4 to 5' minimum freeboard recommended by U.S.B.R. The volume of fill required for the dam is approximately 169,500 cu. yd. Included in this volume are 9000 cu. yds. each of riprap and gravel blanket which will be required. This leaves 151,500 cubic yards, of fill that must be derived from the unclassified spillway excavation. In addition, the fuse plug levee requires 7300 cu. yds. of fill material (Exhibit A-6). The overall earthwork balance shows an excess of excavation over fill of 20,700 cu. yd. This excess is needed for two reasons. First, the template of the existing dam is known to be somewhat different from the 'as built' condition. In particular, there has been settlement approaching 2' near the center of the dam, the downstream slopes are somewhat flatter and the upstream slope to the watersurface is somewhat steeper than originally designed. It is possible that up to 12,500 cu. yd. of additional material actually would be required to bring the crest elevation to 4260.0 ft. msl. Also, it is unlikely that all of the excavated material will be suitable as fill for the dam and/or fuse plug so it must be wasted at the toe of the dam.

Rehabilitation of Principal Spillway

The principal spillway for Cooney Reservoir has been constructed in several stages over the years. The design has been inadequate and maintenance has not been optimum. As a result, the spillway is undersized based on present safety standards and in a poor state of repair. In its present condition, a large flow could cause severe damage to the major structures, and, in the case of an extreme event, the inadequate capacity would result in over-topping the existing dam embankment.

Historically, the principal spillway has operated five times with estimated flows ranging from approximately 1000 to 2900 cfs based on recorded streamflow data below the dam and estimated outlet tunnel discharges at those times. The peak flow of record occurred in 1967 which coincides with the peak flow of record for the two USGS gaging stations above the reservoir. During these periods, severe damage occurred particularly in the form of undermining the flip bucket, as the plunge pool is naturally excavated, and damaging the two lower drop structures. In addition to these problems, the floors of all of the drops are eroding and large slabs of rock are being lifted out and transported through these structures causing severe damage. The design presented is proposed to upgrade this structure so that it is capable of passing the 100-year flood routed through the reservoir without damage.

Two design discharges are examined depending on the flood storage available. The larger design discharge is referenced as the irrigation-recreation option and the smaller discharge as the flood control option. The construction of an inlet control crest, repair of the flip bucket spillway, enlargement of the plunge pool, rehabilitation of the first three drop structures and modification of the outflow channel are all common to both options. However, with the irrigation-recreation option, the two lower drop structures must be replaced with a chute and stilling basin to accomodate the larger flows. A larger outflow channel is also required. Exhibits A-1, A-4, A-5 and A-8 show the general details of the key features established above. Each design item will be discussed below.

Overflow Crest. As an integral part of both design alternatives, an ogee crest combined with a new bridge has been placed in the principal spillway in the approximate location of the existing bridge. The elevation of the crest has been set at 4251 ft (msl). This is 5 feet above the crest of the existing spillway channel. The crest length is 98 ft. The shape of the ogee is based on model studies conducted by the U.S.B.R. on the overflow for Wheeler Dam. At the design head, the coefficient of discharge of this weir is 3.99.

A flood routing study using the 100-year inflow design flood and the established crest configuration yielded a maximum discharge through the spillway for the irrigation-recreation alternative of 3570 cfs. This corresponds to a head on the weir of 4.4 feet. This establishes the 100-year inflow reservoir elevation of 4255.4 ft (msl). For the flood control alternative, with 4200 AF of additional flood surcharge storage, the peak spillway flow was reduced to 2610 cfs due to reservoir routing of the 100-year flood. This discharge requires a head of 3.6 ft. and a resulting 100-year inflow water surface elevation of 4254.6 ft. (msl). For the flood control alternative, four 18" concrete pipes with a combined capacity of 100 cfs would be placed through the base of the crest to provide automatic evacuation of the flood pool. This will assure that the maximum elevation of the reservoir is maintained at 4246 ft. (msl). Using these culverts and the outlet works, the flood pool can be easily evacuated in 7 days.

A new concrete bridge is proposed to replace the existing wooden structure over the spillway. This will provide an added control on the principal spillway. The bottom elevation is set to restrict flows greater than approximately 4000 cfs from entering the flip bucket section. This is the approximate capacity of the existing spillway without overtopping. Exhibit A-6 shows all of the features associated with the ogee and bridge including a 6" reinforced concrete slab and walls which extend from the base of the crest to the existing spillway, a distance of approximately 100 ft. Additionally, a concrete wall will be provided on the upstream side of the left bridge abutment to assure division of flow between the principal and emergency spillways.

Plunge Pool. The design of the plunge pool was based on: (1) analysis of the existing pool which has been naturally enlarged as a result of spillway flows; and (2) by guidelines presented by the Bureau of Reclamation. These criteria indicate that the present plunge pool is of sufficient depth but is too narrow. The geologic character of the material in the plunge pool is such that erosion and displacement of large blocks of sandstone have occurred during spillway operation. The resulting erosion has undermined the flip bucket spillway.

The proposed plunge pool is no deeper than the existing pool but the base will be widened from 50 to 80 feet. The side slopes will be cut back to 2:1 and a curvilinear outflow channel will be provided to the upper drop structure. The entire basin will be lined with large riprap. The extra volume resulting from the widening of the basin will provide adequate dissipation of energy such that the placed riprap will not be displaced and transported out of the basin. The design schematic of this feature is shown in Exhibit A-5.

Existing Drop Structures. The upper three drop structures of 80-foot width have been found adequate to handle in excess of the 100-year flow with the present configuration and with some rehabilitation of the floors. Presently, the concrete on the floors between the first and third drops is badly broken and even absent in places. The exposed rock is eroding in large slabs similar to the plunge pool. The floors above the second and third drops will be paved with 9-inch thick reinforced concrete slab to provide a stable flow surface. This is shown in Exhibits A-5 and A-8.

The lower two drops which are only 50 feet wide are not adequate to pass the larger 100-year flow. These structures will be removed and replaced with a concrete chute as a part of the irrigation-recreation option. However, the flood control option will decrease 100-year flow such that only repair and not replacement of these drops is necessary.

Concrete Chute. The chute spillway was designed to replace the two lower drop structures which are inadequate to handle the larger discharge associated with the irrigation-recreation option. The configuration of the chute is shown in Exhibits A-5 and A-8. The overall length will be 160 feet with a total drop of approximately 37 feet. The chute is 80 feet wide at the top tapering to a 50-foot width at the bottom. The side walls on the chute are 5 feet in height providing adequate freeboard for waves generated in the contraction. A U.S.B.R., Type III stilling basin is located at the base of the chute to provide energy dissipation before releasing flow into the outflow channel.

Stilling Basin. The stilling basin chosen for use at the base of the concrete chute is the U.S.B.R. Type III Basin which is useful in decreasing the length of basin and dissipating high velocity flow. The basin is suggested for use when the Froude number of the incoming flow is greater than 4.5 and the velocity is less than 50 fps which is the case in this design. The basic features of this basin, shown in Exhibit A-8 include chute blocks, baffle blocks and an end sill, all of which aid in dissipating energy and shortening the length of basin required. The basin presented here is only 28.1 feet while a basin length in excess of 70 feet would otherwise be required. This results in a considerable savings in concrete. The proper operation of the basin is dependent upon the required tailwater depth which, at the design discharge, is 12.0 feet. This depth is a function of the hydraulic characteristics of the outflow channel.

Outflow Channel. Several criteria were used in designing the outflow channel including:

1. The depth of flow in the channel must provide adequate tailwater for the stilling basin up to the design discharge.

2. The maximum velocity at design discharge should be less than 5 fps to prevent the need for lining the channel.

3. The side slopes must be 2:1 as recommended in the geologic investigation.

4. The bottom of the channel will be 50 feet in width with the irrigation-recreation option and 40 feet in width with the flood control option.

These criteria lead to the channel designs as shown in Exhibits No. A-4 and A-8. These channels provide adequate tailwater through all ranges of flow up to design discharge of 3570 cfs. At flows above that, some loss in effectiveness of the stilling basin is expected as a result of the loss of adequate tailwater in the outflow channel. A freeboard of 2 feet is provided at the design discharge. Velocity in this channel at design flow is slightly less than 4 fps which satisfies the maximum velocity criteria. This is a suitable velocity to prevent erosion of the shale material.

Effect of Dam Enlargement on Outlet Works

In the process of raising the dam 5.0 feet, the embankment catch points of the upstream face will move approximately 16 feet in plan view. A check was made to determine if this change would interfere with the inlet excavation area and portal of the outlet tunnel. Assuming 2:1 excavation slopes to the inlet portal, the existing catch points of the dam are approximately 20 feet away from the catch points of the excavation. Raising of the dam will bring these catch points almost to the same point. Thus, raising the dam should not require any modification of the inlet area. If slope stability should prove to be a problem, the fill in this area can be sloped at 2½:1 for a short distance with an earth reinforcing or riprap used to insure slope stability. The cost of this work is minor and is assumed to be absorbed in the contingency factor.

Effect of Increased Water Levels on Gate House

The present elevation of the gate house floor is 4,260.0 feet as is the crest of the dam. The water surface elevation during the occurrence of the 100-year flood with the flood control option is 4,255.4 feet or 4.6 feet below the floor elevation. This allows sufficient freeboard without modification. During the occurrence of the Probable Maximum Flood, the water surface elevation will be 0.5 feet above the floor and may cause some limited damage. The control tower will be filled with water and will have to be pumped dry, for example. However, it is thought that the risk of the PMF occurrence is not great enough to warrant raising of the control tower and gate house.

Right-of-Way and Land Acquisition

Enlargement of the dam and reservoir will result in an increase in both normal water surface (the irrigation option) and maximum flood pool elevations. The increase in normal water surface to 4251.0 feet (msl) is approximately equal to the original design elevation with the flashboards of 4250.0 ft. Therefore, additional lands should not have to be required for increasing the conservation pool. Due to increases in flood levels, however, it is recommended the flood easements or land acquisition of approximately 50 acres as shown in Figure VI.4 be obtained. Most of these areas would be subject to inundation only during events more severe than the 100-year flood.

Design Summary

Table VI.3 has been prepared to provide a comparison of the existing situation and the two design alternatives. All of the pertinent data regarding elevations, excavation and fill volumes, design discharges and design features are presented.

To summarize the design alternatives, it is proposed to excavate a large emergency spillway adjacent to the existing principal spillway and raise the dam 5 feet so that protection of the structure can be assured during the PMF. The existing principal spillway will be rehabilitated to provide adequate hydraulic capacity for passing the 100-year flood. Two configurations have been proposed based on allocation alternatives for the additional storage of 4200 AF. If this volume is allocated for irrigation use or to provide an increased minimum recreation pool, a higher 100-year outflow will result. This will require the replacement of the lowest two drop structures with a concrete chute. If the added storage is allotted to flood control, the peak outflow discharge would be routed to a reduced level thereby alleviating replacement requirements for the drop structures. Basic to both alternatives are the following modifications to the principal spillway enlargement of the plunge pool, rehabilitation of the upper three drops, enlargement of the outflow channel.

Table VI.3

COONEY DAM AND RESERVOIR PHYSICAL CHARACTERISTICS SUMMARY TABLE

Parameter	Existing Situation	Irrigation and/or Recreation Alternative	Flood Control Alternative
Height	97'	102'	102'
Crest Elevation	4260.0'	4265.0'	4265.0'
Normal Water Surface Elev.	4246.0'	4251.0'	4246.0'
Active Storage Capacity	24,200 AF	28,400 AF	24,200 AF
100 Yr. Peak Inflow	6010 cfs	6010 cfs	6010 cfs
100 Yr. Peak Outflow	3670 cfs	3570 cfs	2610 cfs
Maximum 100 Yr. W.S. Elev.	4250.9'	4255.4'	4254.3'
Maximum Design Flood	Unknown 1/	PMF	PMF
Maximum Spillway Design Flow	Unknown 1/	52,000 cfs	52,000 cfs
Maximum W.S. Elev.	Unknown 1/	4260.3'	4260.3'
Freeboard at Maximum W.S.	Unknown 1/	4.7'	4.7'

1/ No information is available on hydrologic investigations used in the design of the original structure.

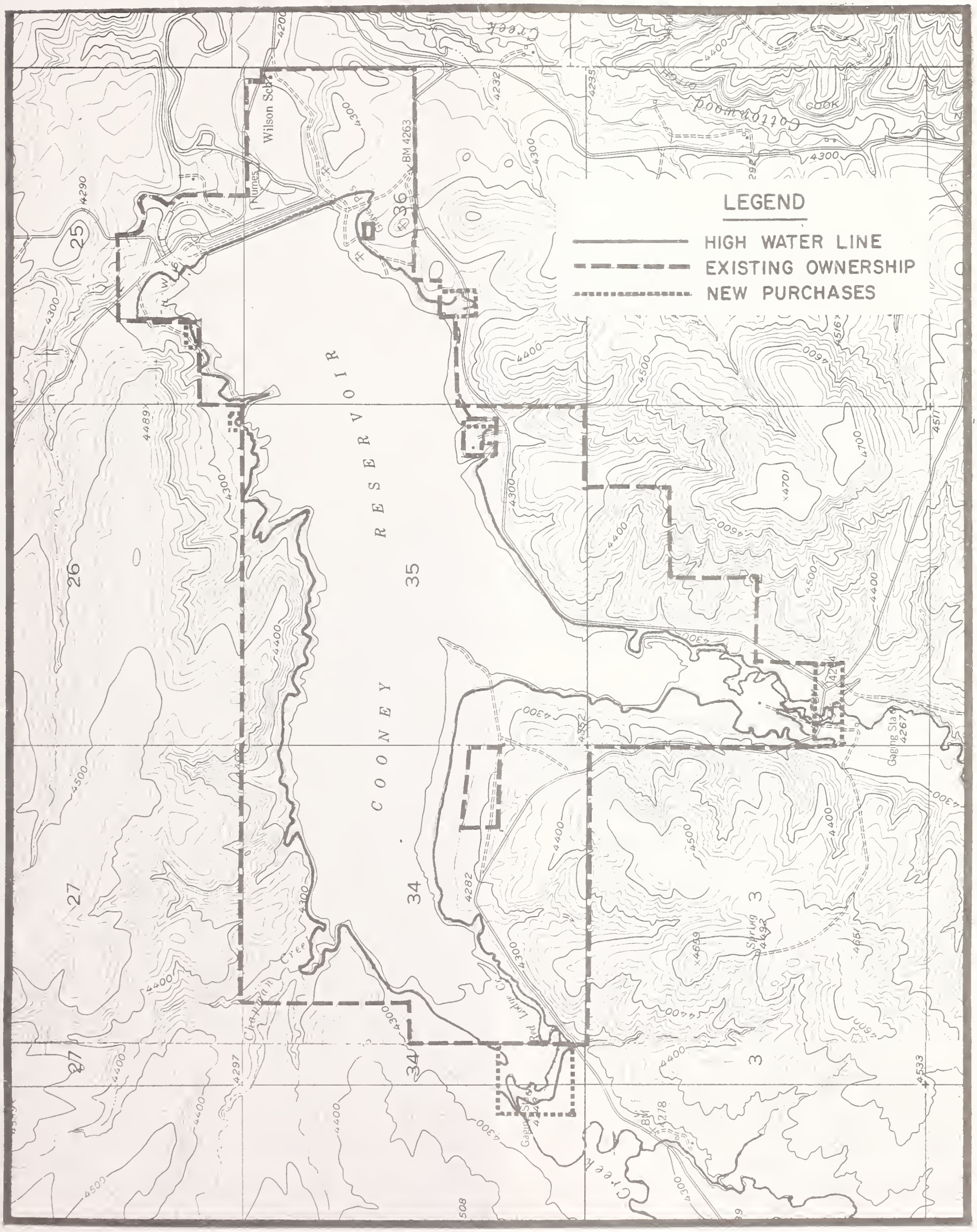

LEGEND
HIGH WATER LINE
EXISTING OWNERSHIP
NEW PURCHASES
COONEY RESERVOIR
Wilson Sch
Nunes
BM 4263
Cottonwood
Creek
Chapman Creek
Lamkin Creek
Rpd
Gaging Sta
4267
Spring
4492
Gaging Sta
4278
BM
4278
25
26
27
34
35
36
3

FIGURE VI-4

CHAPTER VII

ESTIMATED COSTS

Chapter VII

ESTIMATED COSTS

ESTIMATES OF COST

Estimates of cost have been prepared for the construction of the proposed project facilities. They are based on the criteria and general design considerations presented in Chapter VI.

The total estimated construction costs of the project, based on January 1978 cost levels, plus an allowance for projected price increases, are $1,780,000 for the recreation-irrigation alternative and $1,531,500 for the flood control alternative. These estimates include, in addition to direct construction costs, reasonable allowances for contingencies, investigations, engineering, acquisition of lands, overhead and legal fees, interest during construction, and Bureau of Reclamation participation, if a small reclamation loan is sought.

SUMMARY OF ESTIMATED COSTS

A summary of the estimated capital costs, loan obligation, and district contribution appears in table VII.1.

PROJECTED FUTURE COSTS

It is anticipated that contracts for construction of the project will not be awarded before July 1980. On the basis of past history, the cost of construction is expected to rise above the present level (1978). For this reason, a plus factor of 12 percent has been applied to the estimated construction costs of all facilities.

LAND ACQUISITION AND RIGHTS-OF-WAY

As previously stated, the physical plan will include raising of the maximum water surface elevation of Cooney Lake approximately 5 feet. This will require purchase of 50 acres of private land at an estimated cost of $750.00/acre or $37,500. These costs are estimates and are subject to negotiation with the landowners. Additionally, the possibility of land trade exists which would lessen costs.

Table VII.1

SUMMARY OF ESTIMATED PROJECT COSTS

Item	Amount: Irrigation-Recreation Option	Amount: Flood Control Option
Total direct cost,	$1,110,400	$ 954,500
Contingencies (20%)	222,100	190,900
Subtotal	1,332,500	1,145,800
Project price increases (12%)	159,900	137,500
Subtotal	1,492,400	1,283,300
Engineering and overhead (14%)	208,900	179,700
Subtotal	1,701,300	1,463,000
Interest during construction 1/	0	0
Land Acquisition	37,700	37,500
Water Rights	1,000	1,000
Bureau participation	40,000	30,000
Processing of application	(15,000)	(10,000)
Administration of loan	(25,000)	(20,000)
Surveys performed	0	0
TOTAL CONSTRUCTION COST	1,780,000	1,531,500
Loan application report	40,000	40,000
Applicant's filing fee	1,000	1,000
TOTAL PROJECT COST	1,821,000	1,572,000
Less applicant's contribution	671,000	442,500
Rights-of-way	(37,700)	(37,500)
Water rights	(1,000)	(1,000)
Loan application	(40,000)	(40,000)
Filing fee	(1,000)	(1,000)
State appropriation, loan/grant	(591,300)	(363,000)
TOTAL LOAN AND GRANT 2/	1,150,000	1,130,000
Loan obligation	890,000	765,000
Grant	260,000	365,000
Less Bureau expenditures prior to loan		
Processing of application	15,000	10,000
TOTAL APPROPRIATION REQUIREMENT (P.L. 84-984 Loan)	$1,125,000	$1,120,000

1/ Assuming P.L. 84-984 loan with no M & I water and no excess lands
2/ With the recreation option the loan obligation would be $765,000 with a grant of $385,000 as explained in Chapter VIII.

INTEREST DURING CONSTRUCTION

Interest during construction (IDC) will be dependent upon the source of financing and the length of the construction period. For this study, a 1-year construction period is assumed. If the monies are obtained bearing 7 percent interest, this cost will equal $59,500 for the irrigation-recreation alternative and $51,200 for the flood control alternative. If the monies are obtained under the small reclamation loan program, only that portion of the water developed by the project to be used for municipal and industrial purposes or for excess lands will be required to pay interest during construction. Presently, no firm commitment has been made for M & I water and it is assumed that new water will not be used for irrigation of excess lands. With this assumption, IDC will not be charged.

U.S. BUREAU OF RECLAMATION COST

If funds are obtained through P.L. 84-984, the Bureau will incur certain costs which the owner must pay. These costs cover the expenses involved in reviewing and processing the loan application, review of the design, and other costs pertinent to the administration of the loan. The costs are estimated to be 2½ percent of the total construction cost or $40,000 and $30,000 respectively for each alternative. These estimates must be firmed up by the USBR after submission of a letter of intent.

ENGINEERING AND ADMINISTRATION

Contracts for design engineering, construction engineering and quality control have been negotiated. Therefore, these costs are based on estimates using American Society of Civil Engineers cost curves and experience. These estimates include surveying, the preparation of plans and specifications, full time field inspection supervision of construction by a resident engineer and assistance in placing the facilities in operation. These costs have been estimated at approximately 7 percent of the construction cost for design and 6 percent for construction engineering and quality control.

In addition to the engineering, there will be costs of general supervision by the RCWUA, costs of contract negotiations and other miscellaneous items involved in this phase of work. These costs have been estimated to be 1 percent of the construction cost.

The total estimated cost of 14 percent for engineering and administration has been applied to the construction cost estimates.

ESTIMATED COST OF PROJECT FACILITIES

A summary of the estimated costs (excluding the cost of the land, water rights, and Bureau participation) of raising the dam, principal spillway modification and construction of the emergency spillway is presented in Table VII.2. Details of the respective cost estimates are included in Table VII.3 of this report.

Table VII.2

ESTIMATED COST OF PROJECT FACILITIES

Proposed Facility	Total Estimated Cost* Irrigation-Recreation Alternative	Total Estimated Cost* Flood Control Alternative
Dam enlargement	$ 299,500	$ 299,500
Principal spillway modification	730,600	492,300
Emergency spillway	671,200	671,200
TOTAL	$1,701,300	$1,463,000

*Includes contingencies, projected cost increase to 1980, engineering and administration.

CONSTRUCTION PROGRAM

Preconstruction

The exact program of construction for a project of this scope depends to a great extent upon the date the money becomes available. It has been assumed that the loan application will be approved, and the contract validation successfully completed by July 1, 1979. On this date, it further has been assumed that the money will become available and the engineering design commenced.

The design is to be finished, complete with approved plans and specifications by July 1, 1980.

Construction Period

The construction of the spillways and the other project facilities is to proceed concurrently and it is estimated the total period will be 12 months. This allows sufficient time to start construction in the early fall of 1980 when the reservoir can be drawn down to the dead pool. It is expected that the emergency spillway excavation and dam embankment placement will be completed in the fall and winter months while the reservoir is drawn down. The spillway work will proceed concurrently with the work finished during the spring of 1981.

Table VII.3

HURLBUT, KERSICH & McCULLOUGH CONSULTING ENGINEERS

BILLINGS, MONTANA

ESTIMATE

Project _____ Date _____ Page _____ of _____ Pages

Structure _____ Estimated by _____ Checked by _____

ITEM NO.	ITEM	Irrigation and Recreation Alternative			Flood Control Alternative			
		Quantity	Unit Price	Amount	Quantity	Unit Price	Amount	Quantity
1	Bridge and Ogee Crest							
	a) Bridge beams and decking	2000 sq. ft.	30.00	60,000				
	b) Abutments and piers	Lump Sum		15,000				
	c) Concrete in Ogee Crest	141.6 yd^3	250.00	35,400	117.8 yd^3	250.00	29,450	
	d) Gabions in Ogee Crest	96 yd^3	75.00	7,200	80 yd^3	75.00	6,000	
2	Plunge Pool							
	a) Unclassified excavation	4203 yd^3	1.90	7,986				
	b) Rock Excavation	4176 yd^3	20.00	83,520				
	c) Concrete	17 yd^3	250.00	4,250				
	d) Compacted backfill	245 yd^3	5.00	1,225				
	e) Placing Rip rap	1177 yd^3	12.00	14,124				
3	Drop No. 2							
	a) Placing riprap	200 yd^3	2.00	400				
	b) Concrete	173 yd^3	150.00	25,950				
	c) Rock excavation	230 yd^3	20.00	4,600				
4	Drop No. 3							
	a) Placing Rip rap	225 yd^3	2.00	450				
	b) Concrete	200 yd^3	150.00	30,000				
	c) Rock Excavation	400 yd^3	20.00	8,000				
5	Spillway Chute or Drop No. 4&5	Spillway Chute			Drop No. 4&5			
	a) Concrete	420 yd^3	160.00	67,200				
	b) Rock Excavation	4460 yd^3	20.00	89,200	Lump Sum		20,000	
	c) Backfill	450 yd^3	2.00	900				
6	Outflow Channel							
	a) Unclassified Excavation	11,290 yd^3	1.90	21,450	5240 yd^3	1.90	9,955	
7	Emergency Spillway							
	a) Unclassified Excavation	176,800 yd^3	1.90	335,920				
	b) Rock Excavation	9,100 yd^3	10.00	91,000				
8	Fuse plug levee & road							
	a) Compacted embankment	7,333 yd^3	0.80	5,866				
9	Dam Embankment							
	a) Compacted fill	160,500 yd^3	0.80	128,400				
	b) Gravel filter	9,000 yd^3	5.00	45,000				
	c) Rip rap	9,000 yd^3	2.00	18,000				
	d) Compacted embankment	16,300 yd^3	0.25	4,075				
10	Road Relocation							
	a) Unclassified excavation	2,795 yd^3	1.90	5,311				
	TOTAL			1,110,427			954,482	

CHAPTER VIII

PROJECT EVALUATION

Chapter VIII

PROJECT EVALUATION

JUSTIFICATION

Justification of the Cooney Dam spillway modifications evolves primarily from the upgraded safety standards required of dams today. The social and economic impacts resulting from a dam failure would be immense and these impacts are difficult to quantify. Thus, this project is unlike many others in that justification for increased irrigation, fish and wildlife, recreation and frequently occurring flood control benefits are secondary to the safety of the dam. Safety of the dam is in the public interest, even though the state as owner is apparently responsible for this safety. Thus, it follows that a significant portion of the costs should be borne by the public, through (non-reimbursable) use of federal or state funds, with the remaining reimbursement allocated relative to increased benefits to irrigation and recreationists. The following sections attempt to quantify all benefits associated with the proposed improvements.

IRRIGATION BENEFITS

Irrigation benefits stemming from marketing of additional storage water resulting from enlargement of the reservoir can be determined in two ways: (1) the willingness of irrigators to pay for existing storage water. This has historically been $1.35/acre-foot with the 1978 assessment being $2.35/acre-foot; (2) the incremental value of increased yields as a result of a firm water supply. By economic analysis, this has been estimated to be $5.60/acre-foot assuming that agricultural users would support 1/4 of the total marginal value of this water. The latter method was adopted for this report and is summarized in the following paragraphs.

As a first step in this analysis, the magnitude of the shortage of water must be estimated and a determination made of the

effect of this shortage on crop yields. As referenced in Chapter V, Water Requirements, the irrigation depletion, primarily consumptive use, is estimated to be 1.60 acre-feet/acre for the Red Lodge-Rock Creek area. The diversion requirement based on a historical overall efficiency of 24 percent is 6.75 acre-feet/acre with an actual diversion of 5.42 acre-feet/acre resulting in a need for 1.33 acre-feet/acre of additional storage. Considering that 24 percent of this 1.33 acre-feet/acre or .32 acre-feet/acre is actually available to satisfy consumptive use requirements, a 20-percent shortage of water in an average year is indicated.

Crop yields are influenced by numerous factors, one of the more important being the water supply. Numerous studies have been made quantifying yield reductions due to plant water deficits at various growth stages. Two of these studies were used to estimate yields with a partial and full supply of water; the results of which are summarized in Table VIII.1. It can be generally assumed from review of the studies that the "relative dry matter crop yield is proportional to the ratio of actual transpiration to potential transpiration." A further simplifying assumption, which in most cases is validated by tests, is that the yield reduction is closely proportional to the shortage of water, all other factors being equal. Where specific data was not available, this assumption was directly applied.

Table VIII.1

CROPPING PATTERN, YIELDS AND MARGINAL VALUES
RCWUA SERVICE AREA

	Cropping Patterns 1/		Yields			
Crop	Acres	Percent	Partial Supply	Full Supply	Percent Increase	Marginal Value/Acre
Small grains	1,313	7.4	64 bu.	80 bu.	25	$22.81
Corn silage	497	2.8	12 tons	20 tons	67	96.54
Sugar beets	1,953	11.0	16.5 tons	19.5 tons	18	72.45
Dry beans	497	2.8	17 c.w.t.	20 c.w.t.	18	30.49
Alfalfa hay	4,845	27.3	3 tons	3.5 tons	17	23.08
Other hay	7,810	44.0	3 tons	3.5 tons	17	23.08
Pasture	835	4.7	4.8 Aum	6.0 Aum	25	5.19
TOTALS	17,750	100		Weighted Average		29.84/acre

1/ Source: Montana Department of Agriculture and Statistical Reporting Service, Carbon County, 1975.

The next consideration is a determination of the costs and benefits of the increased yields attributable to the full water supply provided. In lieu of preparing a detailed farm budget analysis, a study was used entitled "Enterprise Costs of Irrigated Crops, South Central Montana" as prepared by the Cooperative Extension Service and the Department of Agricultural Economics, June 1976. Modifications were made to each crop budget reflecting changes in variable and fixed costs due to different crop yields. Primary changes were as follows: (1) irrigation labor charges; (2) elimination of the irrigation water charge; (3) adjustment of any material cost such as baleing twine that is sensitive to yields; (4) changes in management cost to reflect the change in gross receipts; (5) a reduction of harvest costs and machinery and tractor fixed costs by a multiplier. For low value crops such as alfalfa and irrigated pasture, the land and implement costs were adjusted downward for both yields considered. These costs were thought to be excessively high given the farming practices typical of the Rock Creek drainage.

It should be noted that studies indicate that fixed and harvesting costs do not change appreciably with different yields. It costs nearly as much to raise and harvest a partial yield as it does to raise and harvest a full yield.

A significant change was made in the alfalfa budget in that harvest costs and fixed costs were changed to reflect an 80-acre operation in lieu of a 40-acre operation. A 40-acre operation was not considered to be economical or representative of the size of operation in the Red Lodge-Rock Creek area. These changes were made using data developed in a report entitled "Hay Harvesting, Storing and Feeding Methods in Wyoming, " July 1973.

After costs were determined for the two yield alternatives, benefits were calculated using equivalent prices received. Marginal values were then calculated as the difference between cost vs. benefits for each yield. The summary of the marginal values/acre can be found in Table VII.1 with the acreage weighted average being $29.84 per acre. The modifications to each budget can be found in the appendix.

It is not expected that all of the marginal value would be applied towards providing the firmer supply of water by farmers and ranchers. It is assumed for purposes of this report that 1/4 of this increased income would be applied towards purchasing an increment of firm water supply in Cooney Reservoir with the remaining economic value as an incentive to purchase water. This difference would allow for lower market prices, economic anomalies, and non use of storage water during the good water years. This would equal $7.46/acre. Considering that 1.33/acre is needed for a firm supply, $5.60/acre-foot of available storage as a result of the Cooney Dam enlargement would be the assessment charge.

FLOOD CONTROL BENEFITS

It is anticipated that the increased reservoir pool would provide additional flood control benefits but the magnitude of these benefits is dependent upon how the reservoir is operated. For purpose of comparison, it is assumed that all of the increased storage would be reserved as a flood pool. It is estimated that the 100-year inflow flood would be routed downward by 1,000 cfs. This would have two positive effects in that it would relieve pressure on the existing principal spillway and it would reduce the flood plain significantly in Red Lodge Creek and, to a lesser degree, in Rock Creek.

To determine the area affected, preliminary studies for the HUD-FIA floodway determination by Morrison-Maierle were reviewed. It is estimated that the urban area flooded can be reduced by 20 acres and the agricultural land flooded can be reduced by 300 acres on Red Lodge Creek during the occurrence of the 100-year flood.

Flood damage assessments are complex and vary widely depending on the characteristics of the flood. Such factors as time of year, depth and duration of inundation, velocity of flow, sediment and debris content and many others should be addressed. It is not the intent of this study to prepare detailed assessments of past and potential flood damage. Instead, an estimate was made of the damage that would occur during the 1-percent chance occurrence or 100-year flood by reviewing other studies. This damage was then annualized by simply multiplying damage costs by 1 percent. In this way the relative magnitude of flood control benefits was estimated for comparison purposes only. If flood control benefits are actually assigned to offset a non-reimbursable cost, a more detailed study should be accomplished to support these benefits.

After reviewing MRBI, SCS and USBR studies, it is estimated that flooding in the Red Lodge-Rock Creek area will cause $50/acre in average annual flood damages in urban areas and $2.50/acre on agricultural land. This results in $2,750 in estimated annual benefits if 4,200 acre-feet of additional flood storage is provided in Cooney Reservoir.

RECREATION BENEFITS

Cooney Reservoir has become an increasingly popular recreation area over the past few years. The following excerpts describe the recreation potential which are taken from a report prepared for Recreation and Parks Division, Montana Fish and Game Department in May of 1968 entitled "A Design Analysis for Cooney Reservoir State Recreation Area."

"Much of the popularity is due to the reservoir's close proximity to the metropolitan area of Billings (48 miles

away), and adequate accessibility from the county road paralleling its southern shore. The fact that there is no suitable body of water for recreation purposes closer to Billings is another contributing factor."

> "The increasingly heavy use of Cooney Reservoir verifies the statistics which show the steady increase in recreation use by urban populations as society becomes more affluent and has more leisure time. Weekend use of the reservoir is so heavy that one observer said you could walk across it by stepping from boat to boat."
>
> "The site of Cooney Reservoir is typical treeless and rolling farmland. The shores are alternately flat and steep, and trees appear only in a few areas along the water's edge where cottonwoods have volunteered."
>
> "Located in the shadow of the Beartooth Mountains to the west, the scenery is magnificent from certain portions of the lake and shoreline. Lack of highly scenic environs immediately surrounding the reservoir, however, precludes Cooney Reservoir from ever becoming a resort area in the true sense of the word. Another deterrent to Cooney Reservoir becoming a true resort is the uncertainty of constant water levels. To date, because of the short season and adequate water flowing from the mountains, water levels have generally been adequate to support recreation use through the season."

Thus, it follows that increased storage would provide increased recreation potential at Cooney Reservoir. If, as with the previous alternatives, all the storage was used to increase average water levels, the average surface area would increase. This increase was calculated by assuming that 17,500 acre-feet are depleted each year and that the minimum pool is increased by 4,200 acre-feet. This would increase the minimum surface area from 355 acres to 480 acres or 125 acres. Alternatively, the maximum water surface would increase from 790 acres to 880 acres or approximately 90 acres. The average increase would be approximately 115 acres if time weighted.

Using 150 recreation days/acre/season, as conservatively estimated from other reports, the reservoir enlargement would increase use by 17,250 recreation days. Using a value of $2.00 per recreation day benefits accrued, the public would equal $34,500 per season. It is felt that these benefits are conservatively estimated as it is obvious that Cooney Reservoir is an important recreation area.

FISH AND WILDLIFE BENEFITS

Paralleling recreation benefits, fishery benefits will also increase with increased average water levels. It is not expected that wildlife benefits would change significantly. Therefore, no benefits are considered. Assuming 50 fisherman days per surface acre annually, an 115-acre increase and a value of $4.00 per day, an annual benefit of $23,000 would occur simultaneously with the recreation benefits.

CHAPTER IX

FINANCIAL PROGRAM

Chapter IX

FINANCIAL PROGRAM

ALLOCATION OF PROJECT COSTS

The repayment of loan obligations needed to fund construction will likely be the responsibility of two entities; the State of Montana; and the Rock Creek Water Users Association. The division of this responsibility has not been determined or negotiated and the purpose of this section will be a presentation of possible alternatives leading to this negotiation. Three groups will benefit in varying degrees from the improvements, i.e., irrigators, fishermen and recreationists, and the public who benefit from flood control. Thus, the following alternatives are presented.

Flood Control Emphasis

With this alternative, the additional 4,200 acre-feet of storage would be reserved for flood control and the reservoir would be operated much as it has been in the past. This would allow additional storage of frequently occurring flood flows which will reduce, considerably, their peaks. This plan has two primary benefits. Included are: damage to downstream property will be further minimized; and, more importantly, the discharge over the existing principal spillway and drops will be reduced to a level where a major modification is not deemed necessary. Thus, rehabilitation costs would be reduced by the cost of the chute spillway, stilling basin and outflow channel excavation. As identified in the cost section, the total construction cost with this alternative is $1,531,500.

It is proposed that 50 percent of these costs be allocated to grants from either the State of Montana or the federal government since the majority of the benefits are public. The remaining costs would be allocated to the Rock Creek Water Users Association as their O & M costs would be reduced and their share in responsibility for safety of the dam would be expressed. Annual equivalent costs are identified in the "Revenue and Payout Options" section.

Recreation Emphasis

This alternative would allocate increased storage to the conservation pool allowing more water for recreation and fishing. Again, most of the benefit would be in the public interest and an allocation is suggested such that the Association cost would be equal to the flood control alternative with the balance allocated to the public via state and federal grants and perhaps camping fees.

Higher flows would occur in the principal spillway. Therefore, the more extensive modifications would be required. The total construction cost is $1,780,000 with the Users loan obligation being $765,000 as suggested in the flood control alternative. This equals a 43-percent cost allocation to the users and a 57-percent cost allocation to the public.

Irrigation Emphasis

With this plan, the 4,200 acre-feet of additional water would be made available to any new users, most likely irrigators, desiring an additional water supply. It is suggested that allocation of costs be such that under the P.L. 84-984 Small Loans Program, a 40-year loan can be obtained and still remain in a category I subsidy standing. This would equal a 49-percent state and federal ($851,300), 51-percent water users ($890,000) cost allocation as detailed in the "Revenue and Payment Options" section. Partial recreation and fishery benefits will exist with the irrigation alternative although maximum drawdowns would be much the same as in the past.

Recommended Combination

As the project progresses into a final plan, various combinations of use or multi-use can be considered as well as allocations of costs. For purposes of comparison, the plans have been evaluated separately in this report. It is recommended that the irrigation emphasis be pursued with recreation and flood control included in keeping with the multiple use concept.

SOURCES OF FUNDING

Funding of large water resource projects is a difficult and time consuming process. The purpose of thi section is to describe the various sources of federal funding available and recommend a program most likely to succeed. State and local options are not discussed as the reader's of this report are most likely to be familiar with those programs. It is clear that, the State of Montana must accept a greater responsibility for financing large water resources projects if they are to be funded on a federal level.

The following discussions are taken primarily from a report entitled "Financing Options for Projects and Programs Identified in the Platte River Basin Level B Study," by Warren Viessman, Jr., Steve Hanke and Jeanne Enevolosen, NWRRI, University of Nebraska-Lincoln, February 1975.

U.S. DEPARTMENT OF INTERIOR BUREAU OF RECLAMATION
SMALL RECLAMATION PROJECTS ACT OF 1956

The small Reclamation Projects Act (P.L. 84-984) established a program under which legal entities located in the 1-percent western-most states can obtain loans for small reclamation projects and grants for those portions of the projects that are nonreimbursable as a matter of national policy. Grants may be made for flood control, outdoor recreation and fish and wildlife enchancement purposes where these purposes are of general public benefit.

The loan application must be accompanied by a check for $1,000 for review and processing.

The portion of the project costs that is properly assigned to irrigation service for lands not in excess of 160 acres in a single beneficial ownership or 320 acres held by husband and wife is free of interest charges. Interest must be charged on the reimbursable portions of the project costs chargeable to providing irrigation benefits to lands in excess of 160 acres in a single ownership, to the production of commercial power, to furnishing water for domestic, industrial, or municipal use, and for the reimbursable portion of those costs allocated to fish and wildlife enhancement and outdoor recreation.

The rate of interest to be paid on such loans is based upon the interest rate on certain long-term obligations of the United States. The rate is determined each fiscal year by the Secretary of the Treasury and will apply throughout the life of the contract to all contracts executed during that fiscal year (12 months beginning July 1 of each year). These rates may change from year to year. The rate applicable for fiscal year is 5-5/8 percent.

The repayment period for such loans must be the shortest practical period justified. The actual payout schedule for a specific project will be dictated by the conditions anticipated and will be decided between the Bureau and the applicant organization. The repayment period cannot exceed 50 years from the date when the principal benefits from the project became available.

Applicants must enter into a contract with the United States which will provide for the repayment of the loan which will cover various provisions for the design, construction, operation, and maintenance of the project and the repayment of Bureau costs.

FISH AND WILDLIFE SERVICE

The Federal Aid in Wildlife Restoration Act, approved September 2, 1937 and popularly known as the Pittman-Robertson Act, was designed to help check the depletion of the nation's wildlife and to insure efficient administration in its restoration.

The Federal Aid in Sport Fish Restoration Act, approved August 9, 1950, and popularly known as the Dingell-Johnson Act, was designed to help protect and restore the nation's sport-fishery resources.

The Acts provide that the federal government may pay up to 75 percent of the cost of work performed by the states on approved projects.

Sources of Revenue

Funds available under the Pittman-Robertson program are derived from a manufacturers' excise tax of 11 percent on sporting arms and ammunition.

The revenue that supports the Dingell-Johnson program comes from a manufacturers' excise tax of 10 percent of fishing rods, creels, reels and artificial lures, baits and flies.

Moneys collected by the Treasurer of the U.S. during each fiscal year are authorized to be appropriated for the succeeding fiscal year for carrying out the purposes of the Acts.

To ensure economy, efficiency and operational uniformity in the execution of these closely related laws, the Secretary of the Interior delegated administration of both to the Bureau of Sport Fisheries and Wildlife (newly named the Fish and Wildlife Service). Many of the procedures developed to carry out the wildlife restoration program have been adopted wholly or in part for its fisheries counterpart.

To participate in these programs, a state must assent to the provisions of the Dingell-Johnson and Pittman-Robertson Acts and shall have passed laws for the conservation fish (wildlife) which shall include a prohibition against the diversion of license fees paid by fishermen (hunters) for any other purpose than the administration of said state fish and game departments.

Only fish and game departments or other authorities vested, under state laws, with fish and wildlife conservation functions are eligible to receive reimbursement for approved projects under the Acts.

To carry out the purposes of these grant-in-aid programs--to restore populations of fish and wildlife and thereby increase hunting and fishing opportunities it is a basic requirement that all fish and wildlife restoration projects be substantial in character and design. They may include activities of the following types:

Coordination - Reimbursement can be approved for the planning and supervision of projects by state personnel to insure effective administration of the work.

Research - Studies designed to develop new knowledge of fish, wildlife or their habitats are approvable.

Surveys and Inventories - Studies designed to provide fish or wildlife management data such as current stocks, harvest information and fisherman or hunter use can be approved.

Land Purchase - States must have adequate control of restoration units prior to the development of capital improvements or the programming of substantial investments on land units. Control may be obtained through purchase, gifts, long-term easements or leases. The costs for such acquisitions can be approved.

Land and Water Developments - Development activities designed to increase hunter and fisherman use of restoration units are approvable. Examples of such work are constructing public fishing lakes, developing access areas to public hunting grounds and fishing waters, planting food and cover crops and stocking birds, mammals or fish where needed. A state must assure the Bureau that adequate planning and design has preceded actual work to insure substantial results.

Maintenance - Federal aid funds can be approved for the upkeep and repair of capital improvements acquired or constructed under federal aid projects.

Management - Work concerned with the harvest or control of wild birds, mammals and fish as a means of managing the resource is approvable.

There are limitations on types of conservation activities that can be funded by the Acts. Conservation programs carried out through law enforcement, information and education and extension activities, important as they may be, cannot be financed. Congress intended that funds appropriated should be used for fact-finding and indirect action programs for restoration of sport fisheries and wildlife.

The Acts require that projects completed under their provisions shall be maintained by the states. A state may not spend more than 25 percent of the moneys apportioned to it under either Act in any fiscal year to help defray maintenance costs.

The Pittman-Robertson Act authorizes expenditures for the management of wildlife areas and resources, but limits expenditures for such purposes to not more than 30 percent of the amount apportioned to a state in any fiscal year. No such limitation on management activities is contained in the Dingell-Johnson Act.

All lands acquired become the property of the states and are maintained and administered by them under state laws. All structures built and all equipment purchased with these cooperative funds also become state property.

One of the critical needs to meet today's demands for outdoor recreation is space. Some land and water areas made available through the Federal Aid in Fish and Wildlife Restoration programs may also be suitable for other types of outdoor recreation. If the associated recreation activities interfere with the primary objectives of the Acts, federal aid participation in total costs must be limited to the part concerned with fish or wildlife restoration. On areas acquired and managed by Federal Aid in Fish and Wildlife Restoration funds, fishing or hunting must be given primary consideration and must not suffer by competition from other forms of outdoor recreation.

The method of allocating Pittman-Robertson funds to each state is as follows: Half in the ratio that the area of the state bears to the total area of all the states; and half in the ratio that the number of paid hunting-license holders of the state bears to the total number of paid hunting-license holders of all states.

Dingell-Johnson money is apportioned to each state as follows: 40 percent in the ratio that the area of the state (including coastal or Great Lakes waters) bears to the total area of all the states and 60 percent in the ratio that the number of persons holding paid licenses to fish for sport or recreation in the state bears to the number of such persons in all the states.

Under each Act an initial deduction, not to exceed 8 percent, is made for administering the Act, and deductions are made for apportionments to Guam, Puerto Rico and the Virgin Islands.

Unused Dingell-Johnson funds revert to the Bureau's fishery research program and unused Pittman-Robertson funds help pay for work conducted under the Migratory Bird Conservation Act.

Money apportioned to any state for any fiscal year unobligated by an approved project at the close of that fiscal year is available for obligation in that state until the close of the succeeding year.

BUREAU OF OUTDOOR RECREATION
LAND AND WATER CONSERVATION FUND

The Land and Water Conservation Fund (LWCF) began January 1, 1965 and is to continue until 1989. The program is 50 percent federally funded and federally guided, but administered by the state with physical accomplishments accruing to local communities. The Bureau of Outdoor Recreation (BOR) provides grants-in-aid to the states and their political subdivisions for up to 50 percent of the cost of acquiring and developing outdoor recreation areas and facilities.

All funds made available under the program are annually appropriated by Congress to the BOR and apportioned to the states on the basis of a prescribed formula. Federal funds allocated to the state in this manner remain available for obligation for a maximum of three years.

The grants-in-aid program based upon and guided by the Grants-in-Aid Manual, which outlines the operating boundaries of the program. All projects funded under this program must be approved by the Montana Game and Fish Commission and submitted to BOR by the state. The BOR determines final eligibility and approves all projects on an individual basis. Federal funds are reimbursed through the state for legitimate project expenditures, not exceeding 50 percent of the approved project cost.

The governing body of a participating community must assume responsibility and assure the state and federal government that it will carry the project to completion and provide matching funds necessary for financing. Financial records of project expenditures must be maintained in a condition suitable for post completion audit. Political subdivisions are also responsible for maintenance and operation of fund assisted, public-use facilities. The BOR or the Fish and Game Commission shall hold no interest or title to land acquired or developments made by a local sponsor under the program.

Acquisition of land to be used for outdoor recreation and dedicated to that purpose forever is one of the primary uses of the Fund. Land

acquired with assistance from the Fund must be appraised by a qualified appraiser and purchased in accord and compliance with state and federal laws governing Uniform Acquisition Procedures and Relocation Assistance. Fund assistance is based upon the appraised fair market value, or court award in condemnation actions.

Development projects may include any public outdoor recreation facility installed on land owned or controlled by the sponsor. The program provides financial assistance for such items as: swimming pools, ballfields, tennis courts, shelter houses, picnic facilities, horseshoe courts, and play-fields, playground equipment, golf courses, restrooms, fencing, landscaping, lighting, roads and parking, campgrounds, archery and trap ranges, beach development, trails, ice rinks, hunting-fishing-nature areas and other outdoor recreation facilities.

It is suggested that many of these facilities could become a part of the Cooney Dam spillway rehabilitation. For example, the emergency spillway area could become an excellent picnic, campground, and parking area with very little relative cost.

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed Protection and Flood Prevention (P.L. 566)

The Watershed Protection and Flood Prevention Act was passed in 1954 and was amended in 1956 (P.L. 1018). The Act established a new national policy for federal assistance to state and local organizations for projects in watershed protection and flood prevention and the conservation, development, urilization and disposal of water.

The objectives of the program are to reduce flood damage, to conserve and store water and to provide adequate drainage and wildlife and recreation facilities; to treat farm and ranch lands so as to reduce water runoff, reduce erosion and siltation, increase fertility and maintain good crop yields; to build gully control and flood prevention structures that are too costly for individual farmers to construct; to provide supplemental water for irrigation, recreation and municipal and industrial use; to drain wetland and stabilize or improve the underground water table. It is a combination of land treatment and structural measures--dams, levees, grade stabilization structures, etc.--to enhance environmental quality, maintain the resource base and improve economic and social conditions in watershed areas. It bridges the resource-development gap between the soil and water conservation work of individual landowners and large federal and state public-world projects for water resources development in major river valleys.

The SCS has the primary responsibility for carrying out the program with assistance from other federal, state and local agencies. State agencies and qualified local organizations can sponsor or co-sponsor an application.

Funds for construction are allocated according to the readiness of local organizations to install, operate and maintain the planned measures.

Farmers will be expected to establish, operate and maintain land treatment measures on all their land and to cooperate in the structural phase of this program. This may include such items as terracing, seeding grassed waterways, seeding eroded land to grass, managing range or pasture properly and using conservation cropping systems that include grasses and legumes. They will also be expected to grant easements and rights-of-way for construction sites for dams and channel improvement and to assist in the maintenance of watershed works.

Local organizations are responsible for needed soil and water conservation treatment which must be applied before or during work on the structures. The organizations are responsible for issuing bids and letting contracts for construction. They are also responsible for operation and maintenance and must sign a written agreement before federal funds are made available for any construction. These organizations can employ an engineer or the SCS will provide this service. They must also obtain all land and land rights needed for a project.

Federal assistance is available when watershed costs do not exceed $250,000 and the size of the drainage area and impoundment do not exceed 250,000 or 2,500 acre-feet respectively. If the estimated federal contribution to construction costs exceeds $250,000, or if the work plan contains a single structure having a total capacity of more than 2,500 acre-feet, other interested federal agencies review the plan within 30 days and send it to the Director of the Bureau of the Budget who transmits it to the Congress. Committees of the U.S. Senate and House of Representatives approve the plan before further federal assistance is made available.

For flood prevention, the federal government pays for all engineering and construction costs. For irrigation and drainage and for public recreation and fish and wildlife development, it pays for all engineering services and up to 50 percent of the construction. In certain circumstances, it pays up to 50 percent of the cost of the land rights and of the minimum basic facilities for public recreation or for public fish and wildlife development. All other costs, including all costs for industrial and municipal water supply, must be paid by the local government.

To help a local organization pay its share of the project cost, the federal government, through the Farmers Home Administration, can make loans. The loans can be for periods of up to 50 years at the federal long-term borrowing rate, with a limit of $5 million for one project. The federal government can also advance money to preserve sites for future construction, once the work plan has been approved. This money must be repaid with interest before construction. Also, the federal government can make money available for the extra cost of developing water supply storage for future municipal or industrial use. No interest is charged and no repayment of the principal is required until water is first used. Interests can be deferred for only 10 years after completion of the storage facilities.

Federal Costs

The federal government pays the following costs:

1) Technical assistance for planning and applying land treatment measures on nonfederal land.

2) A part of the cost, not to exceed the rate provided under other agricultural programs, for certain land treatment measures when specifically authorized by the SCS administrator.

3) Installation of land treatment measures on federal land.

4) All construction allocated to flood prevention.

5) Engineering and other services (including engineering services associated with the administration of contracts) allocated to (a) flood prevention, (b) agricultural water management, and (c) public recreation or fish and wildlife development.

6) Not more than 50 percent of the construction allocated to (a) agricultural water management; and (b) public recreation or fish and wildlife development.

7) Not more than 50 percent of the engineering and other installation services required for minimum basic facilities for public recreation or fish and wildlife development.

8) Not more than 50 percent of land rights required for public recreation or fish and wildlife development.

9) Administering contracts when awarded by a federal agency.

NON-FEDERAL COSTS

Non-federal costs include:

1) Installing land treatment measures on non-federal land.

2) Acquiring all land rights except for public recreation or fish and wildlife development. These costs include removal, relocation or replacement of bridges, roads, pipelines, buildings, fences or wells whether done by the local organization or by the owners.

3) At least 50 percent of acquiring land rights for public recreation or fish and wildlife development.

4) Acquiring water rights.

5) Administering contracts on non-federal land unless work is done by federal contract.

6) All construction not allocated to (a) flood prevention, (b) agricultural water management, and (c) public recreation or fish and wildlife development.

7) At least 50 percent of construction allocated to (a) agricultural water management, and (b) public recreation or fish and wildlife development.

8) Engineering and other installation services not allocated to (a) flood prevention, (b) agricultural water management, and (c) public recreation or fish and wildlife development.

9) At least 50 percent of the engineering and other installation services required for minimum basic facilities for public recreation or for fish and wildlife development.

10) Operating and maintaining works of improvement on non-federal land.

11) An equitable share of operating and maintaining works of improvement on federal land in consideration of the benefits that accrue to non-federal land.

Resource Conservation and Development Loans

Farmers Home Administration and Soil Conservation Service. The FHA makes Resource Conservation and Development loans to public agencies and non-profit organizations in areas that have been designated by the Secretary of Agriculture as Resource Conservation and Development Project Areas.

These loand may be advanced only after an RC&D project plan, developed by sponsors with guidance by the Soil Conservation Service (SCS), has been accepted by the Secretary, and he has authorized SCS and other U.S. Department of Agriculture agencies to help local organizations carry out measures consistent with the plan.

Loans by the FHA authorized by the Food and Agriculture Act of 1962, as amended, help local people meet their share of project costs. RC&D programs to improve the economy of communities in a project area are based on the conservation, development and use of natural resources.

Loans may be made to public bodies which are agencies of states, counties, municipalities and other state subdivisions and instrumentalities, including public agencies created under state law for making public improvements. Loans may also be made to private nonprofit organizations.

Funds may be used for: water facilities, including the construction or improvement of works of flood prevention, erosion control, irrigation drainage of agricultural land, soil conservation and water storage for community supply and pollution abatement. Water resource improvements such as reservoirs, lake level control structures, stream or channel rectification, acquisition of lands, easements, and fees for legal and technical services. Public water-based recreational developments and public water-based fish and wildlife developments to help public entities obtain the local share of costs for such developments for which the SCS is providing RC&D technical or financial assistance. Shift in land use, such as conversion to pasture, forestry, wildlife areas, grazing, parks, greenbelts and other open spaces that will serve rural communities.

Loans may not be used to: buy tracts of land intended primarily for industrial use or later resale to private developers; build motels, housing developments, farm dwellings, dance pavilions; treat land on private or indi-

vidual land units; newly introduce land to agricultural production; build projects consisting primarily of water or waste disposal treatment plants or distribution systems; provide drainage benefits to non-rural areas; pay costs that that could be met through assignment of payments for participation in agricultural conservation programs.

A portion of a tract purchased with RC&D loan funds primarily for non-industrial purposes may be set aside for an industrial park, but RC&D loan funds may not be used to develop or build facilities on the industrial park.

Eligible borrowers may obtain amounts commensurate with the applicant's resources, reasonable cost of the project measure to be financed, and the applicant's ability to repay. A loan may not exceed $250,000.

Loans may be made for periods of up to 30 years. The interest rate is the average rate paid by the U.S. Treasury on obligations of a similar maturity outstanding at the beginning of the fiscal year in which the RC&D loan is made.

All loans will be secured in a manner which adequately protects the interest of the government. Bonds or notes pledging taxes, assessments or project revenues will be accepted as security if they meet statutory requirements. A mortgage may also be taken on the organization's facilities when state law permits.

A borrower's total indebtedness for these loans together with any assistance in the form of a grant cannot exceed $4,000,000 at any one time. The interest rate varies but may not exceed 5 percent.

CORPS OF ENGINEERS

Flood Control (P.L. 74-738)

The primary purpose of this program is to reduce losses of life and property by controlling flood waters. Measures may include dams and reservoirs, levees, flood walls, diversion channels and channel alterations. To initiate the process the Corps of Engineers finances and makes studies authorized by Bongress as a basis for authorization of federal projects and for non-federal guidance.

Should a project be found feasible, and moneys are appropriated, the federal government assumes the total costs, including those for operation and maintenance, allocated to the flood control function of major reservoirs. For local flood protection projects, local interests are required to provide all lands, easements, rights-of-way and utility, highway and structural relocations and alterations; hold and save the U.S. free from damages due to the construction works, and operate and maintain the works after completion.

The Corps does not administer a small projects loan program to the best of our knowledge.

Park and Recreational Facilities at Water Resources Projects Federal Water Project Recreation Act of 1965 (P.L. 89-72), Amended by Water Resources Development Act of 1974 (P.L. 93-251)

The purpose of this program is to provide for public park and recreation facilities at water resource development projects by constructing, maintaining and operating recreational facilities; for granting leases of lands including structures and facilities and in accordance with the Federal Water Project Recreation Act of 1965 participating with non-federal public bodies in provision of such developments under cost-sharing agreements, state, local or federal government agencies without fee; nonprofit organizations for a fee.

Where public interests permits, water areas must be open to public use for boating, swimming, fishing and other recreational purposes. Ready access along shores must be maintained for general public use. Non-federal cost-sharing of 25 percent for separable facilities is based on mutually agreeable plans pursuant to P.L. 89-72. In addition, the non-federal public body is responsible for operation, maintenance and replacement of all facilities developed to support recreation and fish and wildlife opportunities.

RECOMMENDATIONS

Considering the alternatives available, and their adaptability, it is this consultant's recommendation that a small reclamation project loan (P.L. 84-984) be pursued. Input from the BOR and the F.W.S. should be obtained as well as input from state sister agencies. A multi-purpose program should be pursued.

REVENUE AND PAYOUT OPTIONS

The derivation of revenues to pay reimbursable project costs will be based on the three designated alternatives with three comparative interest rates (0, 6 and 9 percent).

A detailed payout schedule for each year of the repayment period is not presented as the source of funding is not firm. However, a summary Table VIII.1 of the annual revenues and payments is presented for comparison purposes.

With the irrigation alternative, there may be one additional division or allocation of costs. That is, the users of the additional water should be expected to pay a greater share of the cost of providing this water at today's prices. The historical water users, who have paid their way for 40 years, should not have as great a burden for repayment under this plan. For purposes of this report, the total loan repayment each year has been divided equally between the new users and the historical users. Because the historical users have a larger share of water, their annual costs are significantly reduced after division. This plan is reflected in Table IX.1.

Table IX.1

COST ALLOCATIONS AND PAYOUT OPTIONS 1/

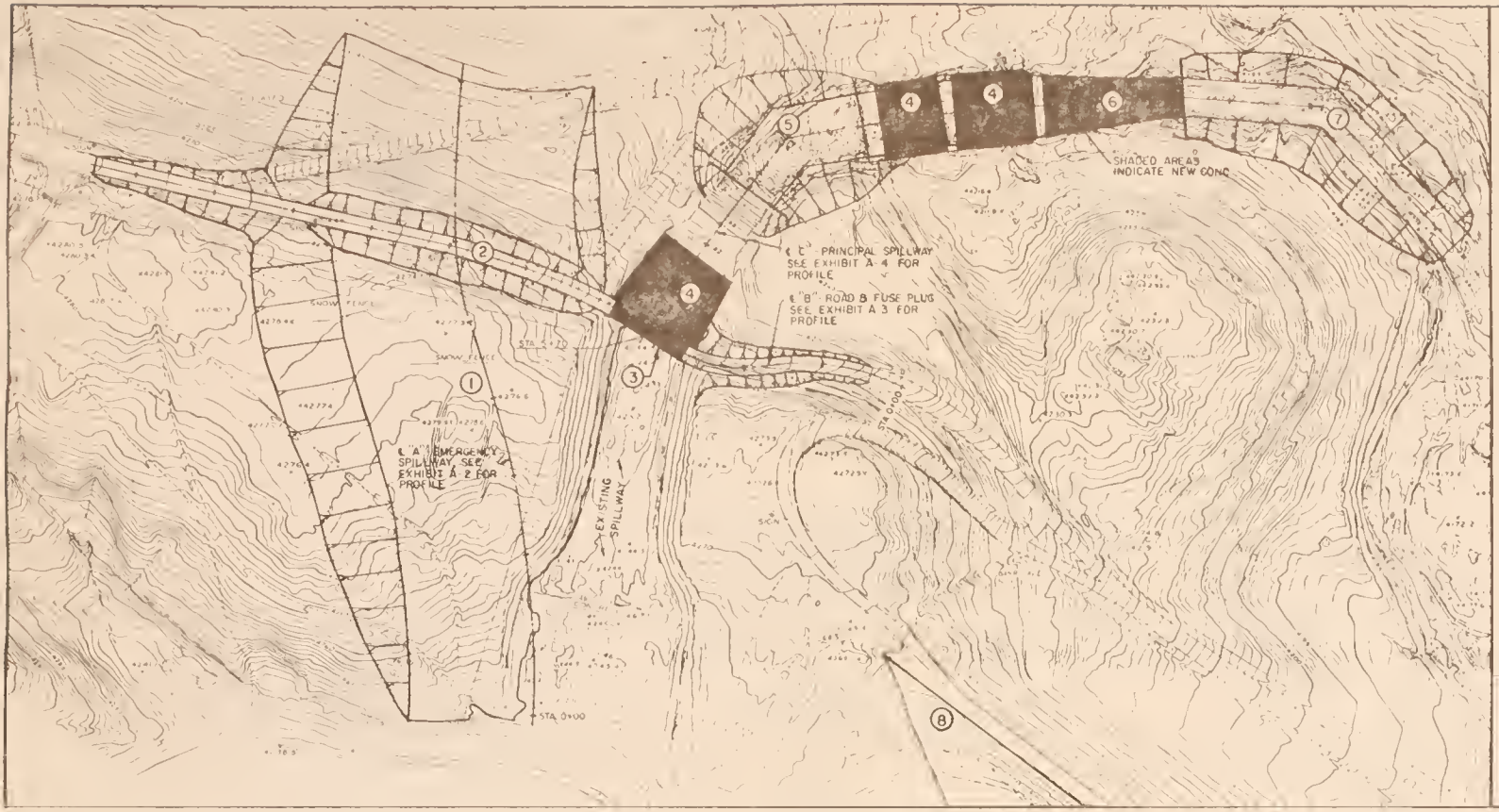
Option	RCWUA Loan Obligation	Federal Grant	State Grant (loan)	Interest Rate (%)	New Users ($/acre-ft.)	Historical Users ($/acre-ft)	Emergency Operating Fund ($/acre-ft.)	O & M all Years ($/acre-ft.)	Total Assessment ($/acre-ft
	----------Cost Allocations----------			------RCWUA Loan Assessment------					
Flood Control	$765,000	$365,000	$363,000	P.L. 984(0)	--	1.08	.10	.35	1.53
	765,000	365,000	363,000	6 2/	--	2.86	--	.35	3.31
	765,000	365,000	363,000	9 2/	--	4.01	--	.35	4.46
(P.L. 984 and state loan)	765,000	365,000	363,000	6	--	2.44	--	.35	2.89
Recreation	765,000	385,000	591,300	P.L. 984(0)			Same as above		
Irrigation	890,000	260,000	591,300	P.L. 984(0)	2.64	.63	.10	.35	3.09* 1.08+
	890,000	260,000	591,300	6	7.04	1.66	--	.35	7.49 2.11
	890,000	260,000	591,300	9	9.85	2.33	--	.35	10.30 2.78
(P.L. 984 and state loan)	890,000	260,000	(591,300)	6	7.32	1.74	.10	.35	7.77 2.19

1/ Based on 40-year term, historical use of 17,750 acre-feet, new use of 4,200 acre-feet.
* New Users
\+ Historical Users

2/ CRF = .06646 for 6%, .09296 for 9%

APPENDIX A

EXHIBITS



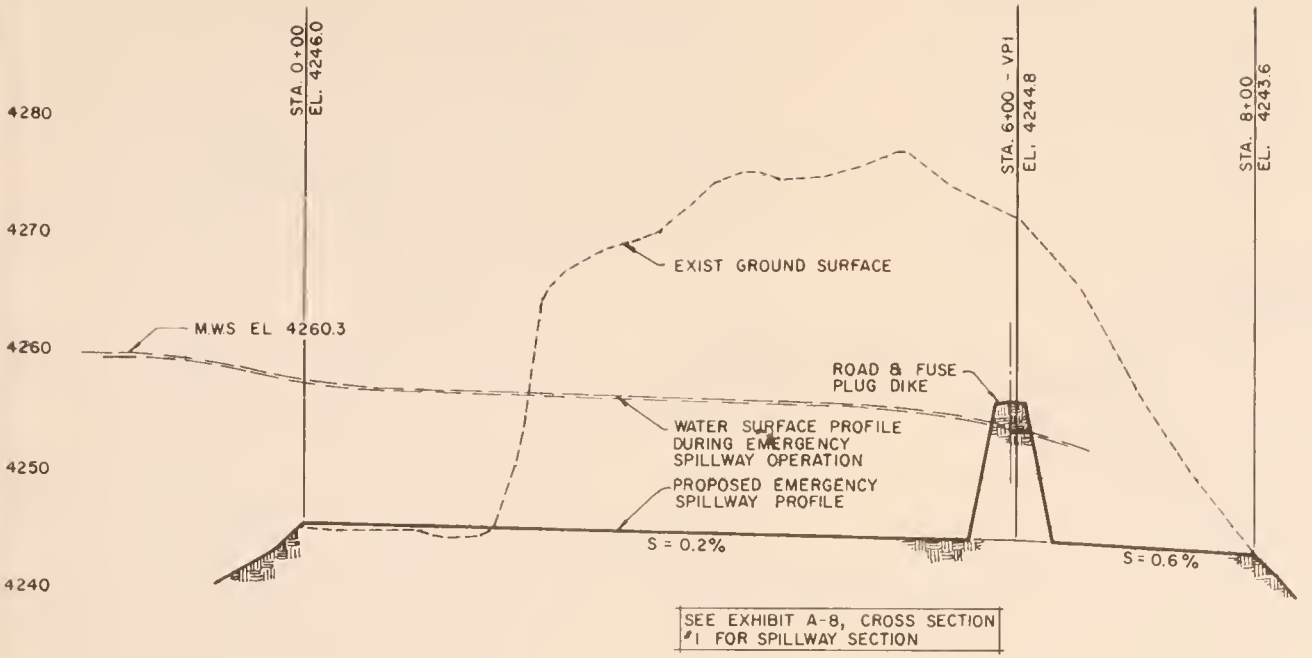
PROPOSED IMPROVEMENTS

1. EMERGENCY SPILLWAY
2. ROAD & FUSE PLUG DIKE
3. NEW CONC. BRIDGE & OGEE CREST - SEE EXHIBIT A-6
4. CONCRETE LINING OF CHANNEL
5. PLUNGE POOL ENLARGEMENT & RIP RAP LINING
6. REPLACEMENT OF EXISTING DROPS 4 & 5 WITH CHUTE (WITH FLOOD CONTROL OPTION, THE CHUTE IS NOT REQUIRED EXISTING DROPS WILL BE REHABILITATED)
7. OUTFLOW CHANNEL ENLARGEMENT
8. ENLARGEMENT OF DAM - SEE EXHIBIT A-7

GENERAL SITE PLAN

SCALE: 1" = 100'

EXHIBIT A-1



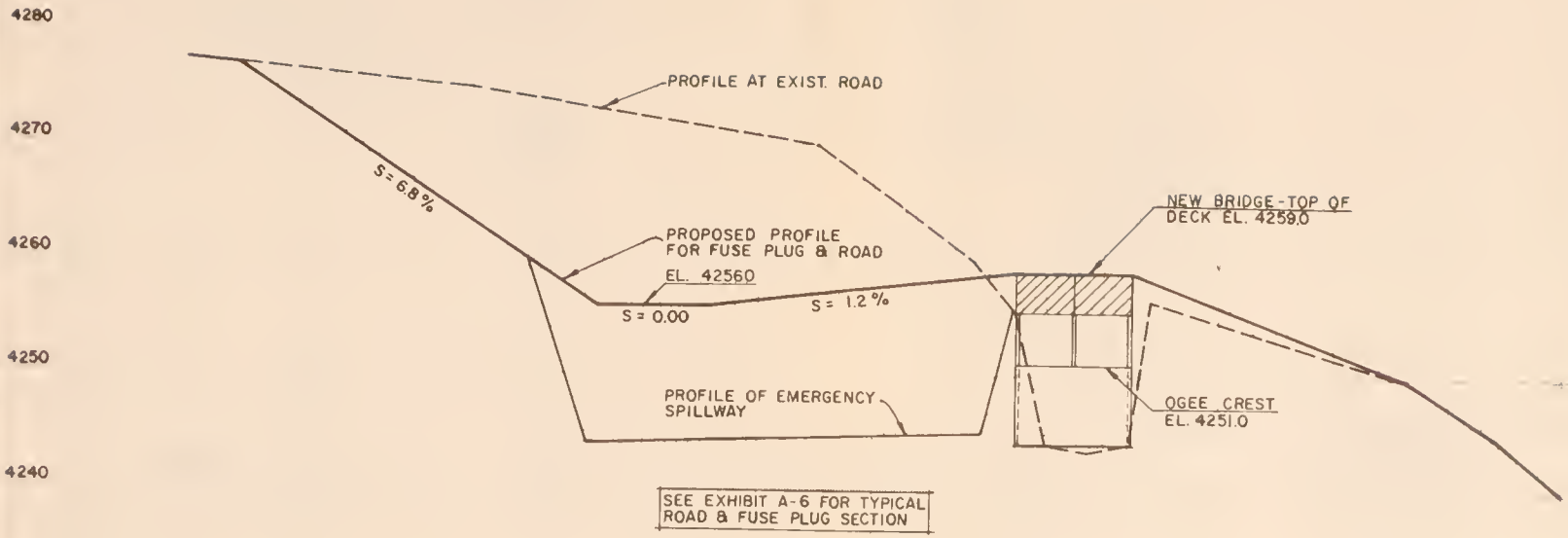
SEE EXHIBIT A-8, CROSS SECTION #1 FOR SPILLWAY SECTION

℄ "A" PROFILE

SCALE: HORIZ. 1"=100'
VERT. 1"=10'

0+00 1+00 2+00 3+00 4+00 5+00 6+00 7+00 8+00 9+00

EXHIBIT A-2

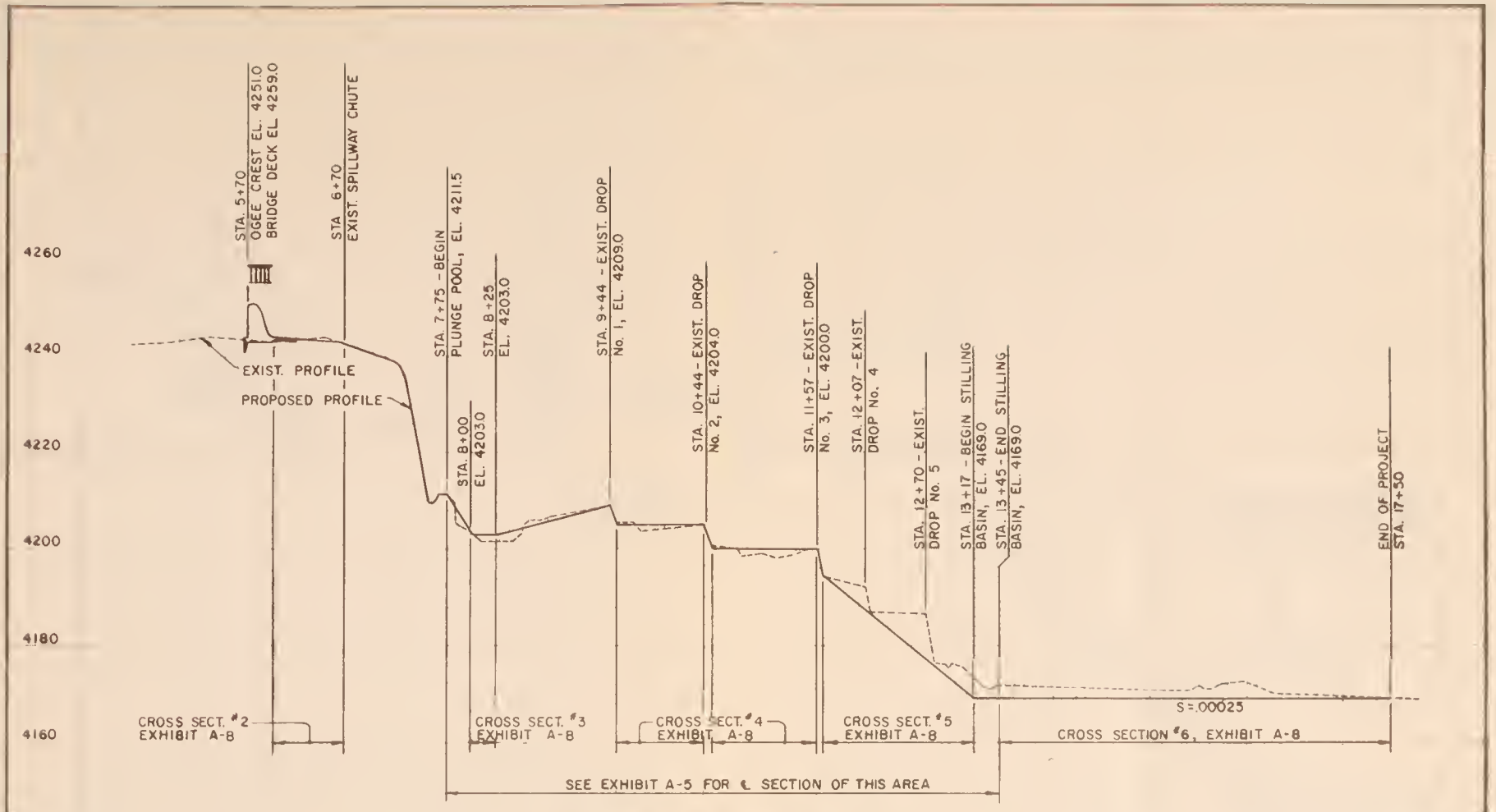


℄ "B" PROFILE

SCALE: HORIZ. 1" = 100'
VERT. 1" = 10'

11+00 10+00 9+00 8+00 7+00 6+00 5+00 4+00 3+00 2+00 1+00 0+00

EXHIBIT A-3

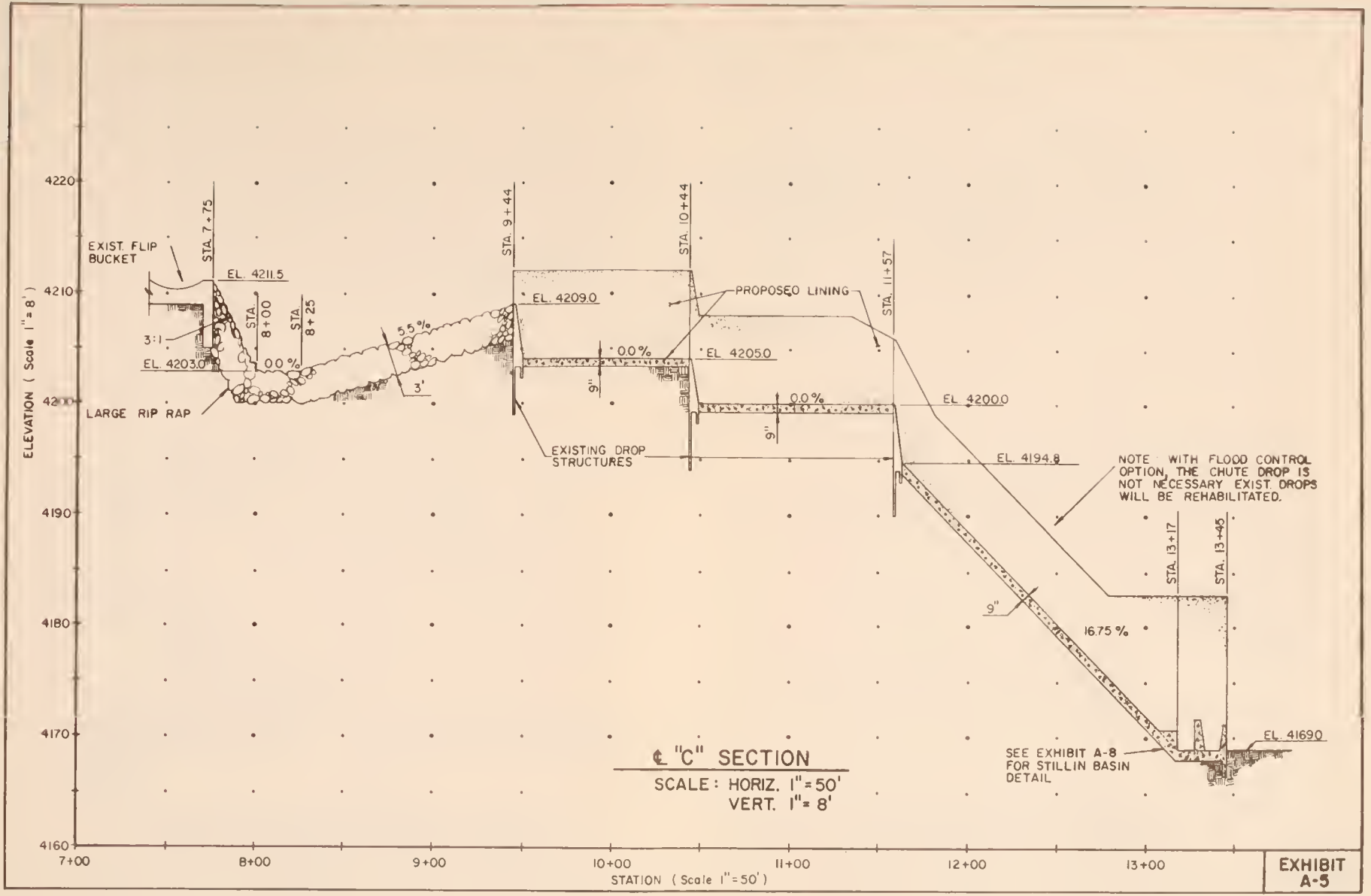


℄ "C" PROFILE

SCALE: HORIZ. 1"=100'
VERT. 1"=10'

5+00 6+00 7+00 8+00 9+00 10+00 11+00 12+00 13+00 14+00 15+00 16+00 17+00

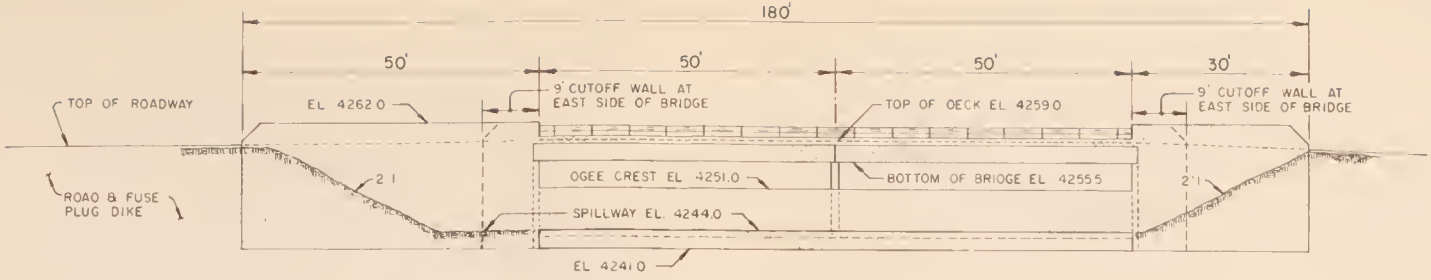
EXHIBIT A-4



℄ "C" SECTION

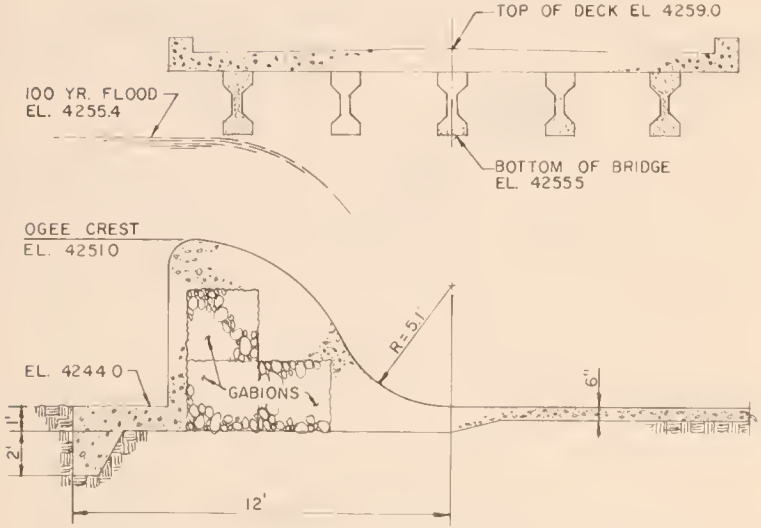
SCALE: HORIZ. 1"=50'
VERT. 1"=8'

EXHIBIT A-5



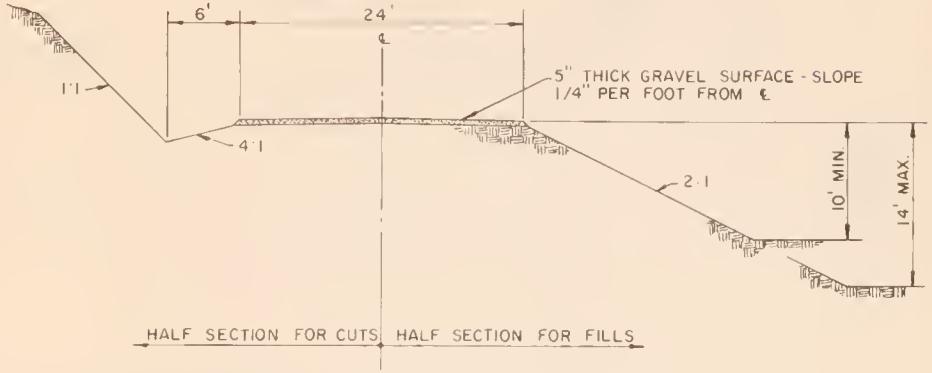
BRIDGE ELEVATION

LOOKING EAST — SCALE: 1" = 20'



SECTION THRU OGEE CREST & BRIDGE

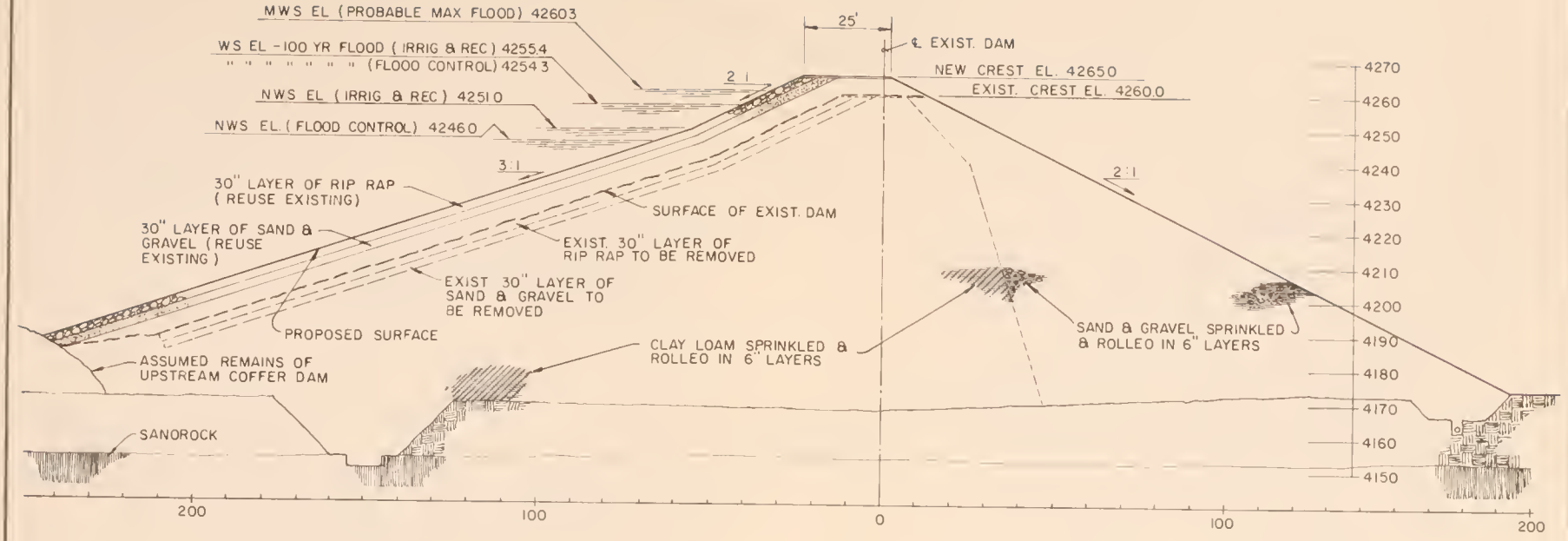
SCALE: 1" = 5'



TYPICAL ROAD & FUSE PLUG SECTION

SCALE: 1" = 10'

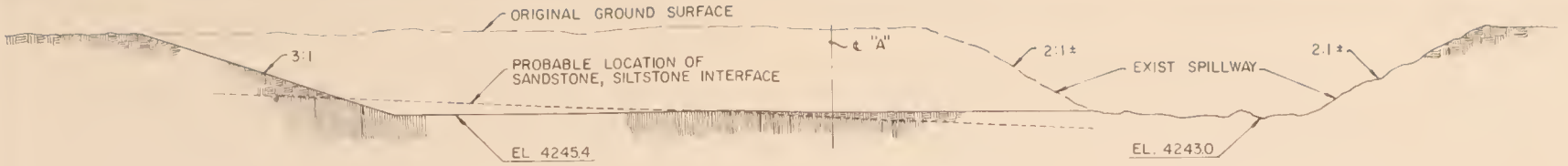
EXHIBIT A-6



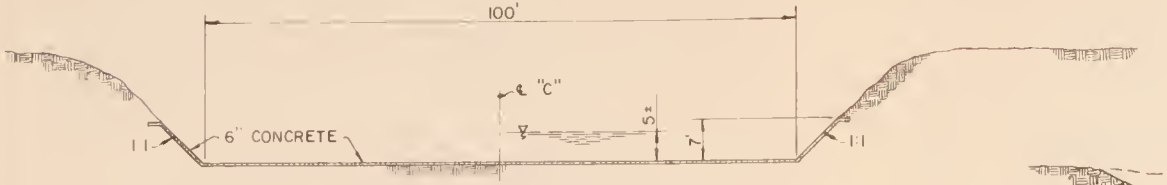
MAXIMUM SECTION OF DAM

SCALE: 1" = 30'

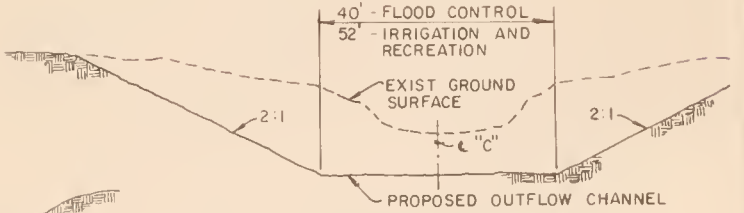
EXHIBIT A-7



CROSS SECTION #1
STA. 3+00, ℄ "A" – SCALE: 1" = 40'



CROSS SECTION #2
SEE EXHIBIT A-4 – SCALE: 1"=20'



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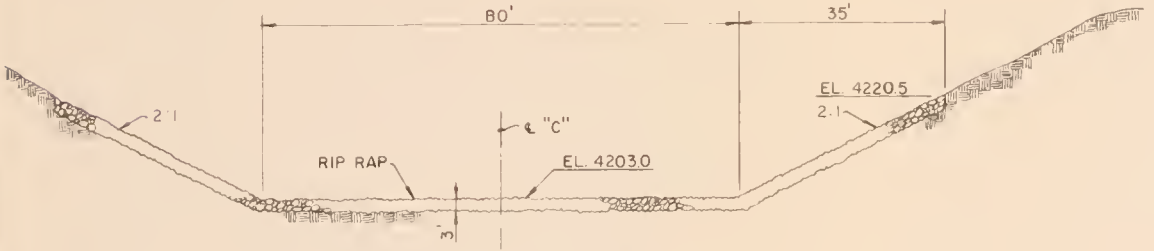

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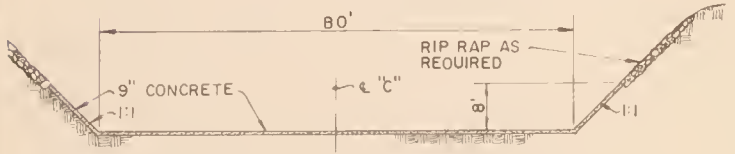

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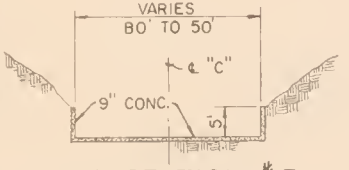

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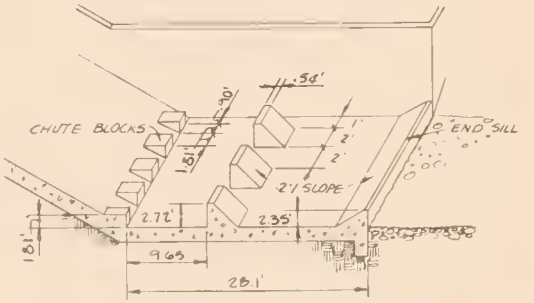
SEE EXHIBIT A-4 – SCALE: 1"=20'



STILLING BASIN DETAIL
SEE EXHIBIT A-5 – N.T.S.

EXHIBIT A-8

APPENDIX B

REPORT OF FOUNDATION INVESTIGATION
COONEY DAM EMERGENCY SPILLWAY

BY

NORTHERN TESTING LABORATORIES

Geotechnical Engineering

Field and Laboratory Investigations
Engineering Analysis and Recommendations
Consultation

Great Falls Billings Montana — Boise Idaho — Gillette Wyoming

P.O. Box 30615
600 South Twenty-fifth Street
Billings, Montana 59103
(406) 248-9161

September 9, 1977

Hurlbut, Kersich & McCullough
P. O. Box 31318
Billings, Montana 59102

Subject: Foundation Investigation
Cooney Dam Emergency Spillway

Gentlemen:

At your request and in accordance with our agreement dated February 17, 1977, we have made an investigation of subsurface soil and rock conditions at the site of the proposed emergency spillway at Cooney Dam, near Boyd, Montana. We have discussed our foundation recommendations with you as the work progressed, and the report which follows describes our investigations, summarizes our findings, and presents our recommendations.

The subsoils consist of a thin layer of silty sand overlying weathered shale with sandstone and siltstone layers, then a well-cemented sandstone.

The soil and shale can be excavated with conventional earth-moving equipment; the deeper sandstone and siltstone layers will probably require blasting, particularly near the base of the spillway.

If you have any questions regarding this report, or if we can be of further service, please contact us at your convenience.

Respectfully submitted,

Leland J. Walker, P. E.

Larry G. O'Dell, P. E.

LJW/LGO/mb
Enclosure
In quadruplicate

REPORT
OF
FOUNDATION INVESTIGATION

COONEY DAM EMERGENCY SPILLWAY
Boyd, Montana

TO
HURLBUT, KERSICH & McCULLOUGH
CONSULTING ENGINEERS
Billings, Montana

PREPARED
BY
NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Billings, Montana

SEPTEMBER, 1977

INTRODUCTION

The purpose of this investigation was to obtain information concerning the subsurface conditions and engineering properties of the subsoil, on which to base recommendations for design and construction of an emergency spillway at Cooney Dam, on Red Lodge Creek, near Boyd, Montana.

Preliminary design details indicate the proposed emergency spillway will be about 200 to 300 feet wide and will lead from the reservoir to an existing spillway. We understand this alignment may be modified. The bottom elevation of the spillway will be approximately 4250, requiring cuts of 20 to 30 feet in some locations: The first portion of the spillway will be level; the latter portion will slope downward at about 1.5 percent.

SITE INVESTIGATIONS

Two methods of exploration were used to define subsurface conditions at the site -- auger borings and NQ diamond core borings. With the auger method of investigation, continuous flight hollow core augers were used to penetrate the soil and rock. Standard penetration resistance tests, using a split-spoon sampler, were made in the undisturbed material ahead of the augers, to obtain samples and provide an indication of in-place density. Diamond core samples were obtained in the bedrock to provide a continuous record of subsurface materials. A rock quality designation number was determined for each core run by summing the length of all sound, hard pieces of core over 4 inches in length and dividing by the total length of core run. This number, as well as the percent of core recovered in each run, is recorded on the drill logs on Drawing No. 77-199-2.

Four test borings were drilled to depths varying from 25.0 to 36.2 feet, at locations as shown on the enclosed Drawing No. 77-199-1. Drill Holes 1 through 3 were made along the axis of the proposed spillway, and Drill Hole 4 was made to evaluate the existing spillway. Each of the borings was continued to at least 5 feet below the proposed spillway elevation. Three of the test borings were located, and elevations determined, by your personnel. One of the borings (Drill Hole 1) was located by our personnel by tape measurement from a road in the area, and the elevation was determined from plan contours.

Continuous logs of the soil conditions were recorded, standard penetration resistance tests made, and samples obtained, during the field drilling program. The surface geology of the site was mapped to aid in correlation between boring locations.

LABORATORY INVESTIGATIONS

Samples obtained during the field exploration were taken to the laboratory where they were carefully inspected and visually classified in accordance with the Unified Soils Classification System. Representative samples were selected for tests to determine the engineering and physical properties of the soils.

These included:	To determine:
Grain-size distribution.....	size and distribution of soil particles, i.e., clay, silt, sand, gravel.
Atterberg limits.....	the consistency and "stickiness," as well as the range of moisture content within which the material is "workable."
Natural moisture.....	moisture content representative of field conditions at time sample was taken.
Slaking.....	the durability and speed with which materials break down, with successive wetting and drying cycles.

The results of all field and laboratory tests are summarized on the enclosed Tables. This information, along with the field observations, was used to prepare the final test boring logs shown on Drawing No. 77-199-2.

SITE AND SUBSOIL CONDITIONS

The emergency spillway will be about 1000 feet north and west of the northwest abutment of Cooney Dam. An existing spillway, which is about 100 feet wide, is between the northwest abutment and the proposed spillway. The general, local topography consists of grass-covered rolling hills. Several sandstone bedrock outcrops are within the proposed spillway area, and sandstone and shale outcrops are evident in the existing spillway and in the local drainages.

The general subsurface profile along the spillway (Drill Holes 1 through 3) consists of a thin layer of sand, underlain by an upper sandstone layer, a layer of shale, and a lower sandstone unit. These materials are described in detail on the enclosed boring logs, and are generalized as follows:

Silty Sand: This material was encountered on the surface and extends to depths of about 1 to 2 feet. It is generally fine-grained, compact, and contains considerable organic material.

Upper Sandstone Layer: This layer extends to depths of about 4 to 8 feet (elevation 4272 to 4266). It is generally moderately weathered, poorly cemented, and fine-grained. Excavation can be accomplished with conventional equipment.

Shale Layer: Underlying the sandstone, a shale was encountered to depths of about 20 to 24 feet (elevation 4256 to 4247). Standard penetration resistance (N) values ranged from 39 to more than 100 blows per foot. This material is generally composed of clay-sized particles, although occasional thin lenses of siltstone and sandstone were encountered. The shale will be subject to moderate deterioration upon exposure to cycles of wetting and drying. It is expected that, generally, excavation of this material can be accomplished with conventional equipment, although heavy rippers will be required. Isolated, well-cemented siltstone or sandstone zones within the shale may require special excavation techniques, and localized blasting may be preferred.

Lower Sandstone: This material was encountered below the shale and extends to the depth of the borings. N values in this material were all in excess of 100. It is extremely well-cemented and has high strength. It is doubtful that it can be excavated with conventional equipment; blasting will probably be required.

At the existing spillway (Drill Hole 4), interbedded layers of shale and sandstone were encountered to the depth of the boring.

Groundwater was not encountered in any of the test borings at the time of our investigation (August 20, 1977). It is expected that, unless the reservoir rises to near the spillway elevation, groundwater will not affect construction.

ENGINEERING ANALYSIS

The existing dam and spillway was constructed in 1939, and water has not reached the spillway every year. The proposed emergency spillway would only be used very infrequently, and would not be subject to extended periods of flow.

Final design details were not available, but we understand the spillway will not be lined. It will be constructed with a flat bottom and sloped sides. An alternate spillway alignment that would discharge water into a drainage north of the existing spillway is also being considered.

If subjected to frequent flow, the spillway would probably require lining or riprap protection. A periodic inspection program should be developed for the spillway, particularly after intervals of flow.

Excavation Slopes

With the present alignment, cuts up to 30 feet will be required. Most of the excavation will be in the shale or sandstone bedrock, and since these materials have a high strength, temporary excavation slopes can be relatively steep. Two conditions will affect the long-term performance of cutslopes in the bedrock materials, and will require flatter permanent slopes. First, a thin zone near the surface of exposed cuts will be subject to slaking -- a softening and strength loss. If the slopes are too steep, this material will migrate to the base of the cut, resulting in flatter slopes. Second, erosion from runoff down the slopes will be severe if the slopes are too steep. Inspection of natural slopes in the area, and slopes in the existing spillway, illustrate these conditions.

Our analysis indicates that temporary slopes in the bedrock will be stable at 3/4:1 (horizontal to vertical), but permanent slopes should be flattened to 2:1.

Materials Evaluation

We understand the existing dam may be modified or raised in the future, and it was requested that we evaluate the soil and rock to be excavated from the spillway for this use. Details of the proposed dam modification are beyond the scope of this study.

1) Silty Sand & Upper Sandstone Layer: When excavated, these materials will generally be granular and in the sand and gravel size ranges. This material could probably be used as permeable drain material.

2) Shale Layer: It is expected the shale will generally break down into small particle sizes when excavated and recompacted. It should be suitable for impermeable liner or core material. Isolated sandstone and siltstone layers within the shale may not break down and would not be suitable for this use.

3) Lower Sandstone: If this material is excavated by blasting techniques, it may be suitable for riprap. Additional studies will be required when the sandstone is excavated to determine its durability.

A sandstone quarry is located near the southeast abutment of the dam. Apparently, this material has been successfully used as riprap at several locations around the dam.

All of the materials encountered will be suitable for use in properly designed stabilizing berms. Additional study will be required for all material uses, after details of the dam modification are determined.

RECOMMENDATIONS

1. Develop a site drainage plan which will divert surface runoff away from cutslopes.

2. Excavation slopes should be no steeper than the following, or be shored:

Material	Temporary Horizontal to Vertical	Permanent Horizontal to Vertical
Silty Sand	1:1	2:1
Shale or Sandstone	3/4:1	2:1

3. Develop an annual inspection program for the spillway. The spillway should be closely inspected after periods of flow to evaluate erosion. If frequent flow occurs, riprap may be required.

4. Special excavation techniques should be anticipated at isolated locations within the shale layer. Blasting should be anticipated if excavations extend into the lower sandstone layer.

The recommendations given in this report are based on the results of the field and laboratory investigations, combined with interpolation of the subsurface conditions between boring locations. The nature and extent of variations between the borings may not become evident until construction. If variations are then exposed, it will be necessary to re-evaluate the recommendations of this report.

If changes in the nature, design, or location of the spillway are planned, the recommendations contained in this report shall not be considered valid unless the changes are reviewed and the recommendations of this report modified or verified in writing.

Respectfully submitted,

Alan Stilley

Alan Stilley, P. E.

APPENDIX

APPENDIX

EXPLORATION AND LABORATORY TESTING

Exploration

Field exploration is performed using truck or skid mounted rotary drilling machine equipped with either augers, tricone rock bits, or coring apparatus. Standard penetration testing and undisturbed sampling can be performed through our hollow stem auger which serves as casing. When drilling in large, dense gravel, rock fragments or bedrock, special casing is usually required to maintain an open hole. The soils are continuously logged by our field personnel and classified by visual examination in accordance with the Unified Soils Classification System.

Samples of soils are taken at frequent intervals in the boring excavation. Disturbed samples are normally taken by the standard penetration test. This test is made by driving a 2-inch O.D. split spoon sampler 18 inches into the soil by striking it with a 140 pound hammer dropping 30 inches. The total number of blows required to advance the sampler the second and third six inch increments is the standard penetration resistance. Occasionally, a cone penetrometer will be driven continuously from the ground surface to locate soft zones or to simulate the driving of piling into subsurface soils. The cone is 1-13/16 inches in diameter and is driven with the same hammer and dropping distance as the standard penetrometer. Undisturbed samples are obtained from layers of soil that are critical to the analysis. Samples of representative soils are obtained by pushing, or possibly driving, a thin-walled steel sampler into the soil layer. The soil is retained in brass rings of 2.00 and 2.50 inches in diameter, and 1.00 inches in height. Normally, the central six inch portion of the sample is retained in close-fitting, plastic, waterproof containers which are in turn placed in cushioned boxes for shipment to the laboratory. Occasionally, thin-walled shelby tubes are used to sample sensitive soils that are easily disturbed.

Under certain conditions and with certain project requirements, in-place vane shear, percolation, resistivity and/or California bearing ratio tests may be performed in accordance with standard procedures.

Laboratory Classification and Testing

The field classification is verified in the laboratory, where all of the samples are classified by someone other than the person who made the field classification. The classification process in the laboratory normally includes estimation of the percents of gravel or rock fragments, sand, silt, and clay fractions, and the liquid and plastic limits. The natural moisture content of all of the fine-grained soil and bedrock samples is determined.

Based on the classification tests, one or more of each representative type of soil encountered is selected for more detailed analysis. The data from the field and the laboratory investigations is used to prepare the final test boring logs (shown on the Drawing).

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

SUMMARY OF FIELD AND LABORATORY TEST RESULTS
COONEY DAM EMERGENCY SPILLWAY
TABLE NO. 1

Job No. 77-199

Boring Number	Depth in Feet	Classification	Penetration Test Blows Per Foot	Moisture Content Percent	Atterberg Limits Liquid Limit,%	Plastic Limit,%	Plasticity Index	Gradation Percent Retained Gravel	Sand	Silt	Cla
DH 1	3.8 - 5.3	SHALE, Claystone	34	13	45	29	16	0	14	58	2
	5.3 - 6.8	SHALE, Claystone	92	16							
	7.5 - 9.0	SHALE, Claystone	42	14							
	12.5 - 14.0	SHALE, Claystone	109	13							
	17.5 - 18.7	SHALE, Claystone	100/0.7	13							
	24.9 - 25.0	SANDSTONE	50/0.1	--							
DH 2	4.1 - 5.6	SHALE, Claystone	66	16	41	28	13	0	39	41	2
	5.6 - 7.1	SHALE, Claystone	42	20							
	7.5 - 9.0	SHALE, Claystone	39	16							
	12.5 - 14.0	SHALE, Claystone	85	14							
	17.5 - 17.8	SHALE, Claystone	100/0.3	6							
	22.5 - 22.6	SANDSTONE	100/0.1	--							
	27.5 - 27.6	SANDSTONE	100/0.1	--							
	32.4 - 32.5	SANDSTONE	100/0.1	--							
DH 3	2.4 - 3.2	SANDSTONE	100/0.3	4							
	7.5 - 8.9	SHALE, Claystone	45	17							
	12.4 - 13.2	SHALE, Claystone	170/0.8	16							
	17.4 - 18.4	SHALE, Claystone	57/0.5	17							
	19.3 - 22.4	SHALE, Claystone	--	--	45	22	23	0	63	20	17
	24.1 - 28.7	SANDSTONE	--	--							
	28.7 - 33.4	SANDSTONE	--	--							
	33.4 - 36.2	SANDSTONE	--	--							
DH 4	0.7 - 3.0	SANDSTONE	--	--							
	4.8 - 8.2	SHALE, Siltstone	--	--							
	8.2 - 10.4	SHALE, Claystone	--	--	37	21	16	0	22	53	25
	11.4 - 13.2	SHALE, Siltstone	--	--							
	13.2 - 18.2	SANDSTONE	--	--							
	18.5 - 20.6	SHALE, Siltstone	--	--							
	20.6 - 22.9	SHALE, Siltstone	--	--							
	23.0 - 25.5	CARBONACEOUS SHALE	--	--							

RESULTS OF SLAKING TEST

COONEY DAM EMERGENCY SPILLWAY
TABLE NO. II

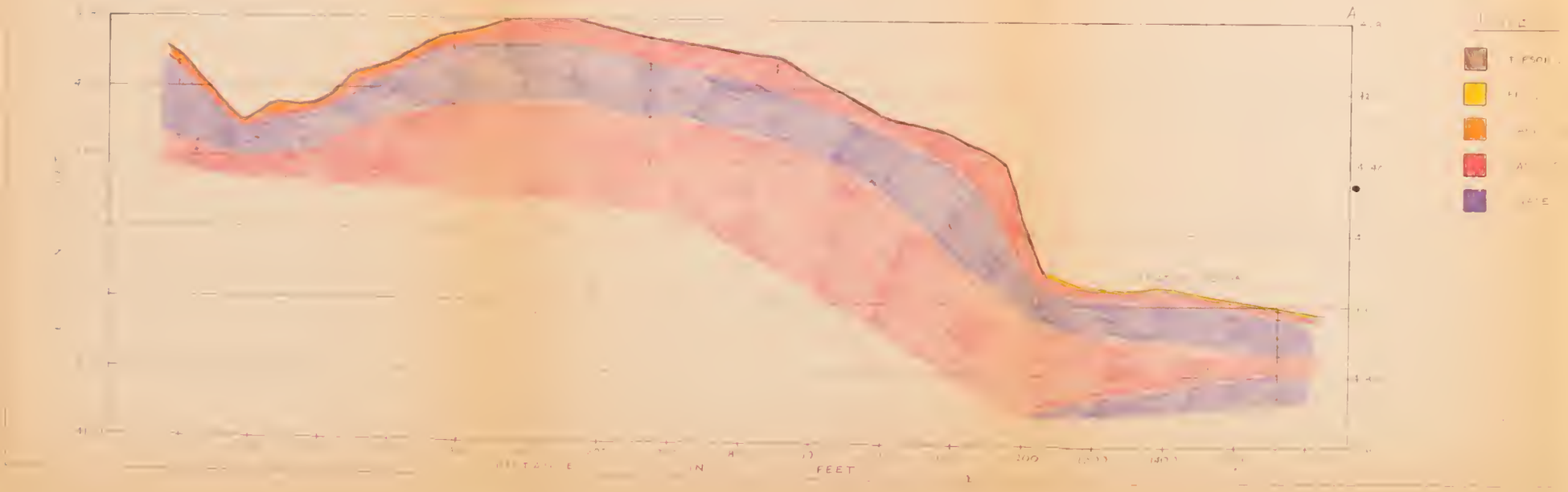
SAMPLE NO. 74801; DRILL HOLE #3; DEPTH: 23.0' - 23.3'

Sequence	Remarks	Sample Description
1	Original sample at field moisture content.	Shale, Claystone; gray, some thin bedding, intact.
2	Sample submerged in water for 10 hours.	Sample slightly slaked, increased cracking, about 20% of sample sand size or smaller.
3	Sample air-dried for 15 hours.	Slight increase in cracking, about 20% of sample sand size or smaller.
4	Sample submerged in water for 8 hours.	Sample moderately slaked, about 30% of sample sand size or smaller.

1" = 50'

TEST BORING

SECTION



HUBBART KERSICH AND ASSOCIATES
BILLINGS MONTANA

BONEY DAM EVERGEEN, W.V.A.

LOG OF TEST BORING AND GEOLOGIC SECTION

FOUNDATION INVESTIGATION

DRAWN
TRACED
CHECKED
APPROVED
DATE

BILLINGS MONTANA

DRAWING NO. 77-199